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MAY, 1956

WORLD OIL

SPECIALIZED FOR EXPLORATION, DRILLING
PRODUCING OPERATIONS AND MANAGEMENT

Gulf Publishing Company

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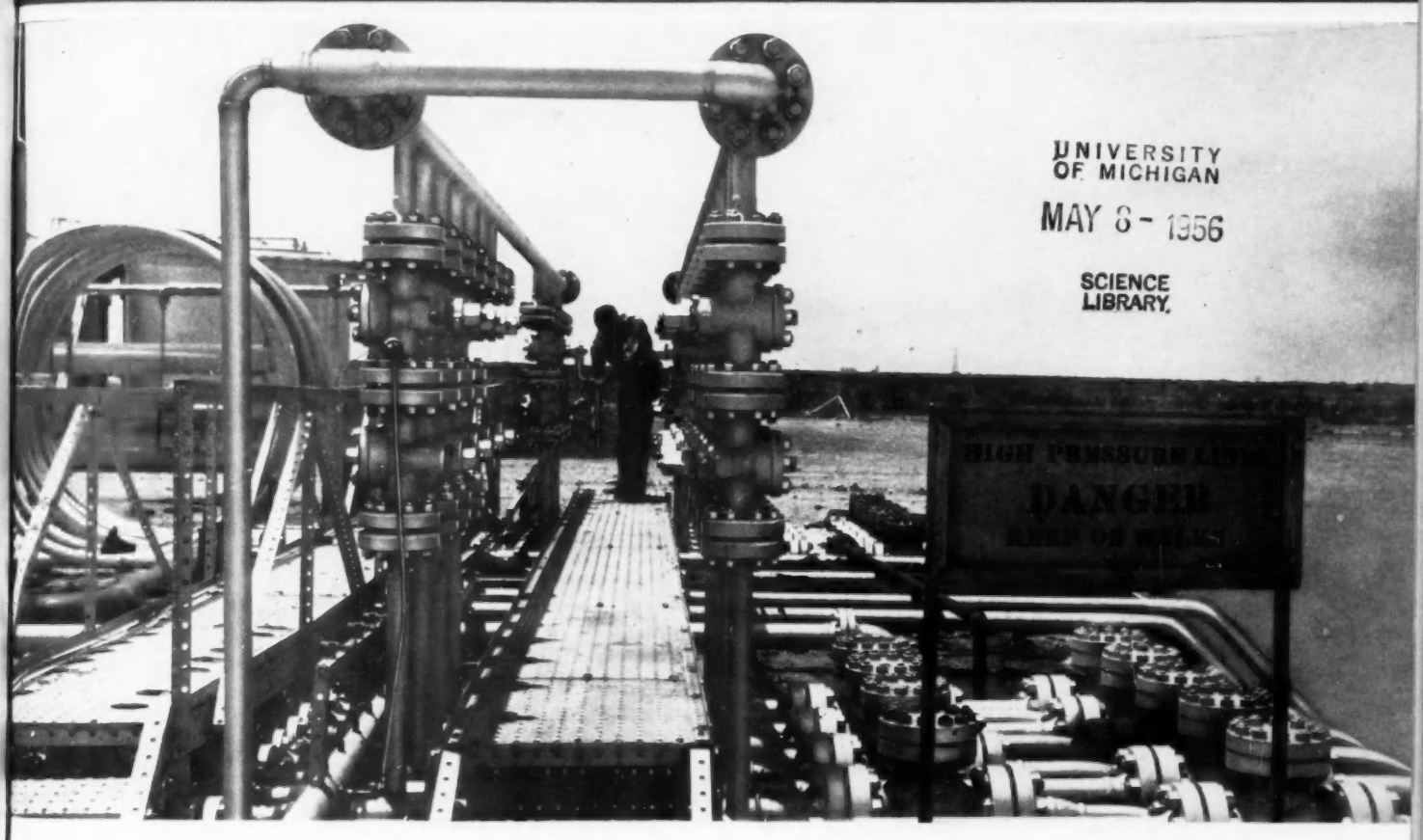
Free World's Oil Picture p98

Radio in Remote Locations...p220



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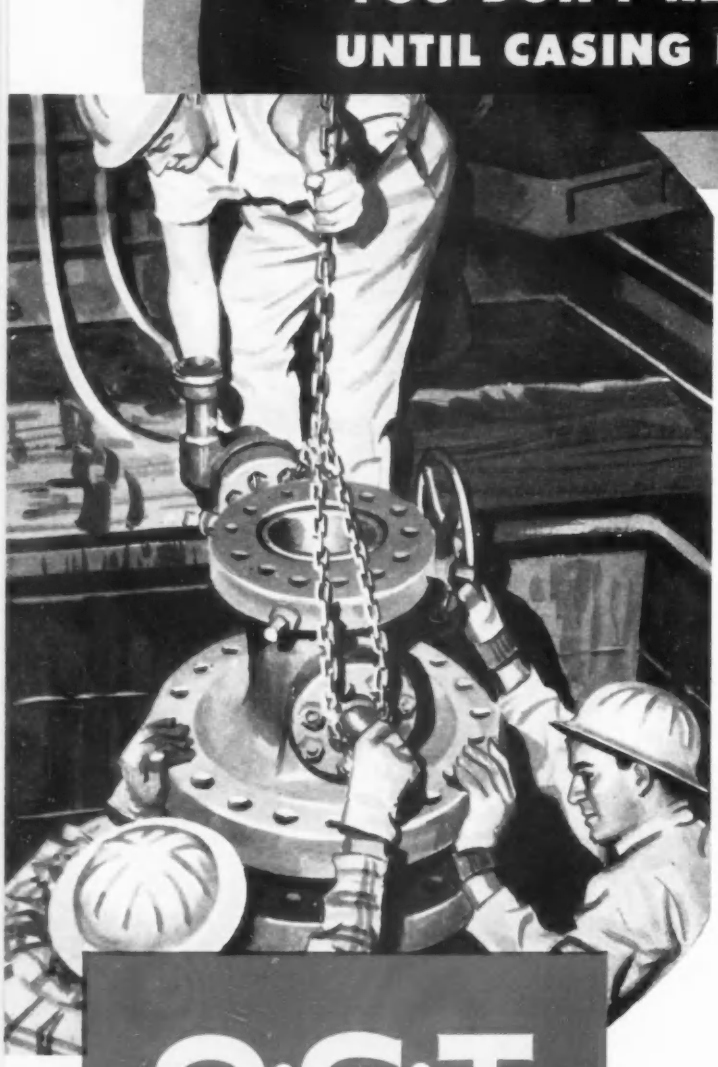

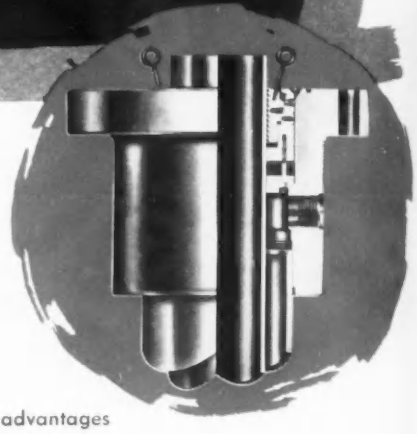

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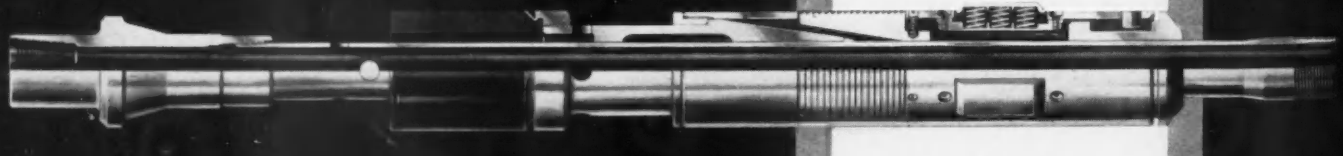
Isn't it time you found out about this O-C-T Packer? It runs, sets and pulls without any difficulty. It's a competitively priced premium packer.



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Established 1916 as The OIL WEEKLY®

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a quick look at WORLD OIL this month

BUSY OIL MEN: To help you put first things first, scan these time-saving digests on this and the following pages, checking ☑ those you want to read first.

SPECIAL REPORT ON FRACTURING

☐ **Production is affected directly** by the depth of a fracture into the formation. What the effect is and how great can it be are discussed in an article beginning on **Page 159.** Also discussed are:

- Established trends in fracturing
- Cost-saving applications
- Future considerations

What Size Fractures? ..... Roscoe C. Clark

☐ **The technique of formation fracturing** has undoubtedly been one of the outstanding improvements in the field of completion and remedial practices during the past decade. Seemingly, the technique finds no serious challenge in any area. Granted, some field pays respond tenfold while reservoirs found in other sections of the country, or world, indicate limited improvement. But the method can be classed as universally successful. The San Juan Basin is one area where the technique has shown astounding results. Turn to **Page 164. What Hydraulic Fracturing Has Done for San Juan Basin** ..... **B. G. Taylor.**

☐ **One-hundred percent safety** in formation fracturing is the goal of producers and service companies alike. To help reach this goal, Humble Oil & Refining Company has compiled a list of suggestions on safe procedures for formation fracturing. You'll want to keep this list. **27 Rules for Safe Fracturing. Page 168**

☐ **A mechanical wire-line formation fracturing tool** which fires a high-velocity missile has proved successful in the oil field. Firing a missile vertically to

Turn the Page ▸

achieve speed and then turning it into the formation, the gun delivers a "Sunday punch" where it is needed. Turn to **Page 170 for details. Perforating "Around the Corner"** ..... **Raymond L. Doyle**

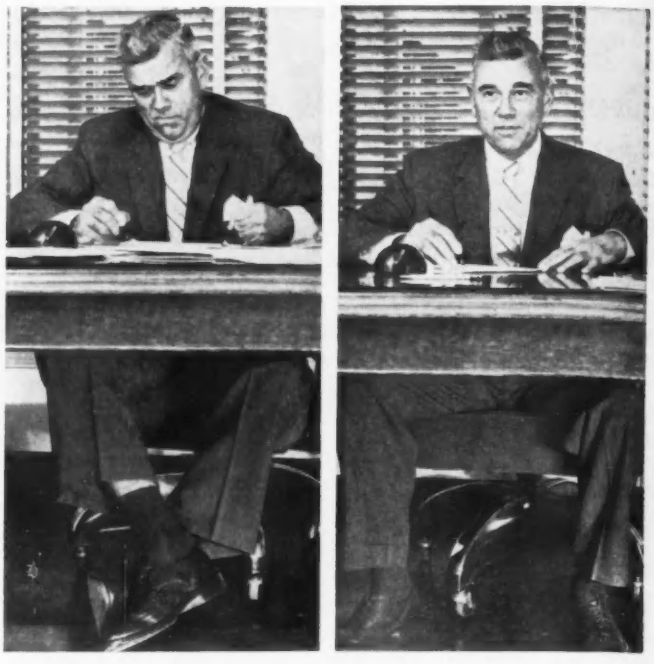
☐ **Good results in fracturing** depend on study and planning. What must you know about your formation? What types of materials are required? And in what amounts? What fracturing fluids have been successful in sand formations? What are some of the problems which will be encountered and how can they be solved? For the answers to these and other questions, turn to **Page 174. Planning a Fracturing Treatment in a New Area** ..... **C. L. Gore**

☐ **Elliptical fractures** with major axes perpendicular to flow usually will provide better sweep efficiency than those parallel to flow. This is one of the conclusions reached by using an electrical analog model with input and/or output wells fractured in a line-drive pattern. For more information on the effect of elliptical fractures on water-flooding or gas cycling performance in these reservoirs, turn to **Page 182. What to Expect from Elliptical Fractures** .... **Paul B. Crawford and Denton R. Wieland**

☐ **Electrical analog model studies** have indicated how circular horizontal fractures at the top, bottom and middle of the pay section affect the production capacity of a well. Pay thickness, radius of drainage, and radius of fracture, as well as the symmetry of the fracture, are all shown to have a direct effect on results to be obtained from fracturing a formation. Experiments show that long single fractures are more effective than short multiple fractures. The effectiveness of an inclined fracture to increase production is shown to decrease as the vertical angle increases. In the second part of this article, the authors establish a graphical relationship between the effect of multiple horizontal fractures and producing capacity of a well. See **Page 196. Do Horizontal Fractures Affect Production Capacity?** ..... **Paul B. Crawford and Bobby L. Landrum**

CURRENT OUTLOOK

☐ **Whether or not oil industry prices** will be increased in the early future may be determined largely by the trend of prices of commodities in general. Prices of petroleum and products traditionally follow closely the trend of prices of all commodities in the aggregate. It is now indicated that new wage-price increases may become general around the middle of the year. Expected wage and price increases in the steel industry probably will be followed by similar increases in many other lines. If and when those increases occur, prices in the petroleum industry would be likely to increase, too. See **Page 82. General Wage-Price Hikes May Push Oil Prices Up** ..... **L. J. Logan**



Which man are you?

☐ **If you ever find yourself** in the condition of the man on the left, you'll be interested in reading this article. Management experts have reported that nervous tension is making life miserable for thousands of working men and women . . . not to mention what it is costing industry in lost production. Here are the details of how Ethyl Corporation is solving this serious problem. **Nervous Tension Can Be Controlled** .. **Page 66**

☐ **Do you have any definite plans for retirement?** How will you pay for it? Shell organizations have started a thought-provoking Planning-for-Retirement program that already is showing some excellent results. **Blueprint for Retirement** ..... **Page 60**

☐ **Uranium may become a byproduct in oil field water-flooding operations.** Two groups in Oklahoma are seeking to develop commercial recovery of uranium from injection waters in connection with secondary recovery of oil. A pilot plant has been built in the Nowata area and the operators have completed 8 water-flood producing wells and 15 water injection wells. The Atomic Energy Commission is helping in the experimental project. **See Page 62. Uranium from Oil Flood Waters?** ..... **Anthony Gibbon**

Are you a watchdog? One successful supervisor says that the hardest thing for him to learn was not to be a ringmaster or watchdog over the people in his department. This is just one of the leadership "secrets" expressed in a survey of 25 supervisors. Look these ideas over. You certainly will find some that will fit your operations . . . **"These Get the Job Done for Me."** ..... **Page 64**

WORLD OIL, published every month except semi-monthly in February and August. Entered as THE OIL WEEKLY as second class mail matter December 25, 1916, at postoffice at Houston, Texas, under the act of March 3, 1879.

Looking Ahead . . .

. . . **The outlook for the oil industry continues to look good.** Demand for petroleum products is running substantially above last year. Markets for crude oil and products are firm. The industry had a quite profitable year in 1955, and it has fared similarly well so far this year.

. . . **While these spring days are bright, there are some slightly disturbing clouds above the horizon.** They include those hanging over farming and automobile production. Depressed farm prices and lagging automobile sales eventually could have an adverse effect on demand for petroleum products.

. . . **Cause for some anxiety is given also by the current and prospective upward spiraling of wages and prices.** It is not known presently just how the petroleum industry will fare henceforth in this new round of inflation. Although oil industry costs have been steadily increasing, prices of oils have not been changed materially for three years. The oil industry raised wages of its employes last year and again this year. It began paying higher prices for steel and other materials last summer and fall. It is confronted with still higher prices this year for steel, aluminum, copper, and other materials. It is predicted that by midyear, steel wages will go up 15 to 20 cents an hour and that steel prices will rise about $10 a ton.

. . . **To compensate for higher costs, better prices for crude oil and petroleum products are hoped for.** So far, the only compensation for higher operating costs has been an increased volume of business. Sales of oils have increased. The current wave of inflation makes better crude and product prices increasingly essential to the health of the industry.

. . . **The industry is now in the season of lowest demand for all oils in the aggregate.** May will bring the smallest daily average demand of the year if history of the past several years is repeated. Use of distillate fuel oil and residual fuel oil will be down seasonally, and gasoline consumption will not be up to the levels to be expected later. Total petroleum use will increase somewhat after May, due to seasonally larger gasoline consumption. But the coming six months, May through October, are traditionally the months of lowest total oil use. Heaviest consumption occurs in the six months from November through April, when colder weather requires large volumes of fuel oils.

. . . **In line with seasonally lower demand for petroleum products, U. S. crude oil production is due to be held down** to a comparatively low level in the immediate future. Allowable production in Texas in May was set at 3,289,240 barrels daily by the Texas Railroad Commission in its order of April 19. This average will be achieved by retaining 16 producing days as in April. Since May has 31 days compared with 30 in April, the average allowable per calendar day figures out 79,331 barrels lower for May than April. Representatives of 11 oil companies recommended 16 or less producing days for May. Suggesting 16 days were Humble Oil & Refining Company, Sun Oil Company, The Texas Company, and Continental Oil Company. Five companies said 15 producing days would provide them with enough crude. On that schedule, Texas output would have been curtailed about 220,000 barrels daily. Those five companies included Atlantic Refining Company, Gulf Oil Corporation, Magnolia Petroleum Company, Sinclair Oil Corporation, and Tide Water Associated Oil Company. Phillips Petroleum Company and Stanolind Oil Purchasing Company recommended 14 producing days for May.

. . . **Some grades of steel may be less scarce after the middle of the year** if work stoppages in the steel mills do not occur. This prediction was made recently by a steel company executive. He explained that some steel consumers heretofore have been building up their inventories in anticipation of a possible steel strike and increases in prices of steel products. Items in tight supply in the petroleum industry include tubular goods especially. Helping to ease the pressure for steel in the third quarter will be some new plant capacity coming into production as well as the expected decrease in buying for inventory.

. . . **California and Gulf Coast operators angling for offshore fields must try to hook the really big ones** and pass up the ordinary ones. On land they can hope ultimately to squeeze a profit out of marginal fields. But offshore, everything costs dearly, Offshore fields offering slow pay-out are definitely non-commercial. Hope of profit is ruled out by heavy costs of drilling barges, platforms, auxiliary boats, service and docking facilities, and weather problems.

F.L.A. added to the fracturing medium in this treatment helps solve fluid loss problems.

KEEPS FLUID LOSS UNDER CONTROL

F.L.A.* (Fluid Loss Additive) is a petroleum derivative in the form of a free-flowing black powder which is designed to lower the fluid loss of fracturing fluids.

When added to an oil well fracturing medium such as crude oil, gelled crude, refined oil, or an acid-oil or water-oil emulsion, F.L.A. substantially lowers the fluid loss characteristics of the medium. During a fracturing treatment, F.L.A. acts to lay down a film on the face of the formation and the natural fractures. This reduces fluid loss into the formation and makes possible longer fractures and deeper penetration of sand. F.L.A. can be added to either the sand or the fluid.

Clean-up is fast, too. F.L.A. is completely soluble in medium and low gravity crudes and only slightly less soluble in high gravity distillates and kerosene.

Let Dowell engineers help you solve your fluid loss problems. The treatment they recommend will be tailored to meet the characteristics of your well.

For more information, or service, call any of the 165 Dowell offices in the United States and Canada; in Venezuela, contact United Oilwell Service. Or write to Dowell Incorporated, Tulsa 1, Okla., Dept. E-13.

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services for the oil industry **DOWELL**

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Oysters or Eagles?

By REV. KENNETH W. SOLLITT
First Baptist Church, Midland, Mich.

The oyster is endowed with a ready-made house to live in. All he has to do is to open the doors of his house to take in his food and close them again to keep out his enemies. He has perfect social security. Yet he is the easiest fish in the world to catch, crush, and cook. He always ends up in the soup. So what does his vaunted security really amount to?

The eagle, on the other hand, is peculiar among created things in another respect. When a severe storm strikes, all other birds either hide from the storm or try to fight it as long as their strength holds out. The eagle neither fights nor runs away. He simply sets his wings so the fury of the storm itself lifts him above the storm where the sun is shining, and there he remains, "free as a bird," until the storm is over. And only a fool would pity the eagle because he isn't an oyster.

The road to freedom in America must begin with the decision as to what kind of freedom we want. Is it freedom *from* something, or freedom *for* something?

To our forefathers, freedom meant the right to risk capital in the hope of a return on their investments; the right of unlimited expansion of their businesses; the right to let the people, in true democratic fashion, cast their ballots in the cash registers of the nation for the businesses which served them best. Freedom to them was a positive thing, and they wisely chose the eagle as their national emblem.

•

More recently we have been indoctrinated with the negative idea that by "freedom" we mean freedom *from* taking risks and making our own choices and decisions. This negative attitude toward freedom exhibits itself in the very expressions we use. Instead of freedom *for* life, liberty, and the pursuit of happiness, we speak of freedom *from* want, worry, and war (and work too, if possible). And we have been so busy fleeing from these spectres that we have turned a corner and run right into their arms.

We have sought freedom from fear so avidly that all it has gotten us is a fear of freedom. We are fast becoming a nation of oysters. Instead of following the time-honored custom of honest men and enjoying the freedom to work for, save for, and buy the things we want, we have thought that it would be easier to elect men to Congress who would give us what we want at the expense of others.

And so our new immoral freedom to take by law that which belongs to another has destroyed the old freedom to enjoy unmolested the fruits of our ingenuity and toil. First, we must decide which kind of freedom we want in the years ahead, the freedom of oysters or the freedom of eagles, the freedom of parasites or the freedom of noble men, the freedom of pirates or the freedom of honest persons.

Second, if it is the freedom of honest persons that we hope to enjoy, we must resist all tendencies toward further socialization, for socialism is piracy. Socialism is robbing the man who earns for the benefit of the one who doesn't. It is in every sense a system of "the survival of the sickest" because it robs the ambitious of their initiative and keeps the people who never had any initiative from developing any.

•

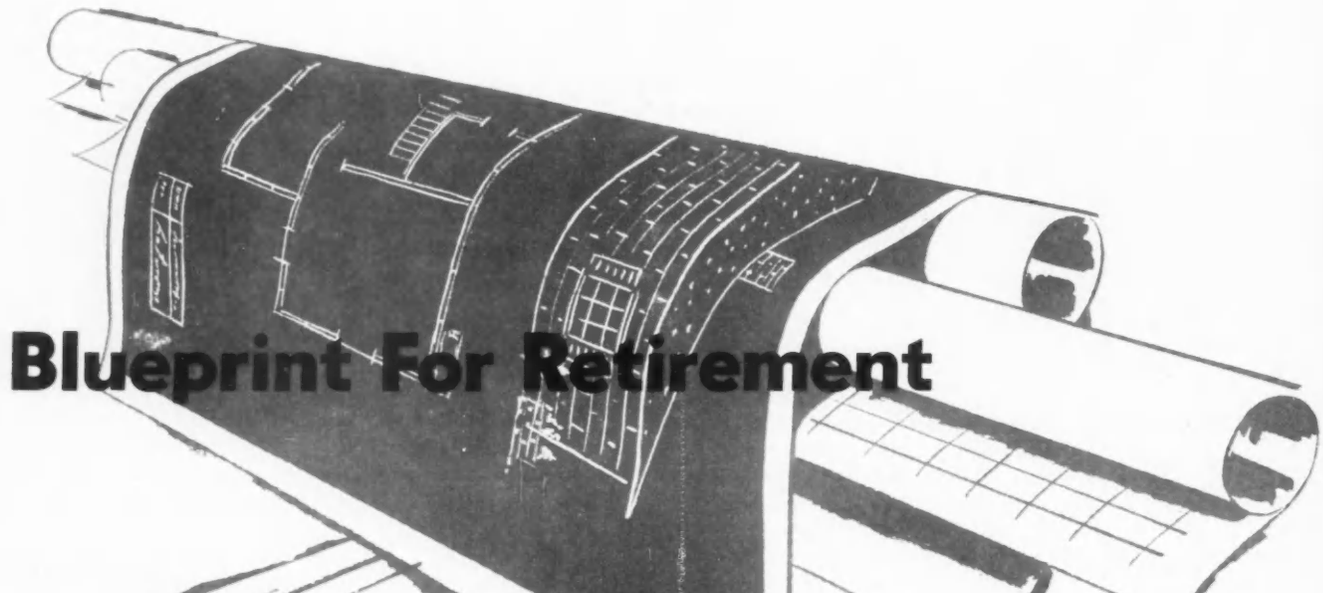
Socialism has demonstrated four facts over and over again:

- You can't multiply wealth by dividing it.
- It does no good to get rid of a few little monopolies by creating a big one called "government."
- The government can't give what it does not first take away.
- It can never take away enough to supply the ever increasing demands of those who are led to believe they are getting something for nothing when they get it from Uncle Sam.

If we want to be a free people, we must begin to do what we ought to do because we ought to do it and not just when we are forced to it. This demanding that we be forced to be good before being willing to behave, is the root of much of our trouble. Burton Parks in *Better Homes and Gardens* put it this way: "We'll never reach maturity in America until we get over the idea that whatever is legal is also moral."

No people can long maintain their freedom unless they are morally worthy of it. The only alternative to the imposition of controls from without is the exercise of controls from within. The only alternative to being forced to do what we ought, which is a form of slavery, is to do what we ought because we want to—and this is the only basis on which freedom can be built.

Let us here dedicate ourselves to showing that covetousness doesn't pay, that liberty is never license to do as we please but only freedom to do as we ought, and that freedom is only for those who will accept the responsibilities that go along with it.



Blueprint For Retirement

Shell's planning-for-retirement program is starting employes to thinking about the future.

A LARGE OIL company recently found that among 722 employes of retirement age:

Fifty-three percent were anticipating retirement, few of whom had plans for the future.

Thirty-two percent were indifferent—had made no plans.

Fifteen percent actually resisted retirement.

Another oil company reports that only one out of 25 of its employes has given serious thought to retirement. When the day comes for them to leave the company, the remaining 75 percent face the important—and sometimes tragic question: Retirement, then what?

The oil industry is taking pioneering steps to eliminate this question from the minds of its employes.

An excellent example is that of three companies—Shell Oil, Shell Chemical and Shell Pipe Line. They established a "Planning for Retirement" program on a trial basis in 1952. It matured in 1955 when preretirement discussions on a voluntary basis were made available to employes in nearly every Shell location.

Before establishing the program, Shell officials determined that postretirement difficulties vary with individuals and different types of jobs. Readjustment may not be as simple for refinery workers as for drilling, producing and pipe line people in the field. Chances are the latter will stay put in the small communities in which they have been working—where they have established strong social ties and perhaps have purchased a little land or become otherwise rooted.

But the refinery worker, having spent his working years in the hustle and bustle that surrounds the larger plants, is more likely to long for the peaceful rural life. He is the man who will benefit most from a sound company retirement program.

Shell found that the situation is not so acute with women employes. Most of them plan to return to housekeeping.

Framework of the Program. Once the need for the retirement-aid service was determined, Shell selected employes experienced in personnel matters to handle the program. They were trained in all aspects of retirement and its problems. As more workers were trained for the job, they spread out to such widespread operations as exploration and producing areas. Men conducting the program in these areas often travel great distances to employes seeking the service.

Herbert Leasure, of Shell's head office personnel department helped establish the program. He now assists in coordination throughout the Shell organizations.

"We offer information on a variety of subjects," says Leasure, "but a lot of times we just serve as good listeners, because many people need nothing more than an opportunity to talk out their own accumulation of thoughts about retirement."

Leasure points out that given an opportunity to talk, an employe's ideas often fall into place in an orderly pattern for future action.

The first goal of the men handling the retirement interviews is to get an employe started *thinking* about retirement and what it involves. If an individual has any ideas or opinions about what he should do after retirement, it is up to the retirement consultant to help explore them and determine if they are practicable.

Company officials are quick to point out that they do not tell anyone how to spend his time or money. Stimulating thought is the big aim. Once interest is generated, the employe will develop his own plans.

How the Program Works. Employe participation is strictly voluntary. At each location, the manager sends a personal letter to the employe approaching retirement age. This letter merely reminds the employe that the service is available. Those who indicate a desire to participate are then invited to sit down in private and confidential discussions with the person handling the program.

Four discussions, usually spread about two months apart, take up specific retirement problems. The employe's views or plans concerning these problems are dwelt upon. The employe is under no obligation to attend the discussions.

The first talk covers the general purpose of the "Planning for Retirement" program. The desirability of planning and what to plan for are explained.

The second discussion deals with finances, company benefits, social security, etc. It has been found that many employes have little knowledge of their company retirement plans. A check list is also provided to help the employe determine the nature of the important papers and records he has, where they are kept and where to go for advice concerning such matters as insurance policies, stocks, bonds and real estate.

The third session usually deals with health and physical condition. A physical examination is provided at company expense. The employe may use either a company doctor or a doctor of his own choice. This phase of the program is mainly to encourage periodic physical examinations. The company keeps no record of the examination. However, it does give the person facing retirement some idea of his physical limitations, if any, which should be considered in planning activity after he leaves the company.

The fourth discussion concerns problems which the employe may have discovered during the three previous meetings. This session also covers where to live and what to do during retirement.

In addition to the interviews, each participant in the program is given an outline of the service, a series of articles dealing with retirement and a bibliography of books and magazines devoted to the many different aspects of retirement.

Benefits of the Program. Shell's retirement-aid program is still in the embryonic stage. Counselors are working with veteran employes who are within a year or so of retirement. The eventual plan is to contact every employe five years before he reaches retirement age. However, tangible results already are beginning to show:

- The discussions gave a shift foreman the idea that he could get closer to his favorite hobby by purchasing a fishing lodge. He is now happily engaged in his own business.
- A retired pumper, who had hunted quail all his life, is now raising quail for commercial purposes.
- A stenographer purchased a large house and made a duplex out of it. She recently added a garage apartment. Her business venture—resulting from the discussions—has proved both profitable and interesting.

Retirement Counselor J. E. James of Shell's Houston office describes the program in the following manner:

"It is not a counseling service in the truest sense of the word, outside of the financial aspects. I see it as an opportunity to ask our people four times a year . . .

". . . Do you have a 'blueprint' for retirement?"

Facing this one fact can mean the difference between a happy and an unhappy retirement. —**The End**

Seven Steps to Happy Retirement . . .

1. **Plan your investments with an eye toward retirement—save part of what you earn.**
2. **Decide what you will do with your time after retirement—start preparing for it before you retire.**
3. **Develop the right mental attitude.**
4. **Have a home paid for by the time you retire.**
5. **Protect your health.**
6. **Make lasting friendships.**
7. **Take active interest in church work, civic affairs, politics or similar activities.**

By 1962, oil operators may be competitively selling . . .

URANIUM FROM

By ANTHONY GIBBON
World Oil Staff

A project which some day may make uranium a valuable by-product in water-flood operations, is under way in the Nowata area of northeastern Oklahoma.

Working "under wraps," two oil groups are spending some $500,000 in an effort to develop a commercial method to extract the valuable mineral from injection waters used in secondary oil recovery operations.

The pioneers in the unique project include Samuel L. Shepherd and the B. P. Smith Land and Cattle Company of Dallas holding 23,000 acres under lease, and J. Tom Grimmett of Pauls Valley, Okla., who organized the American States Oil Company to further the project. American States has 2600 acres under lease.

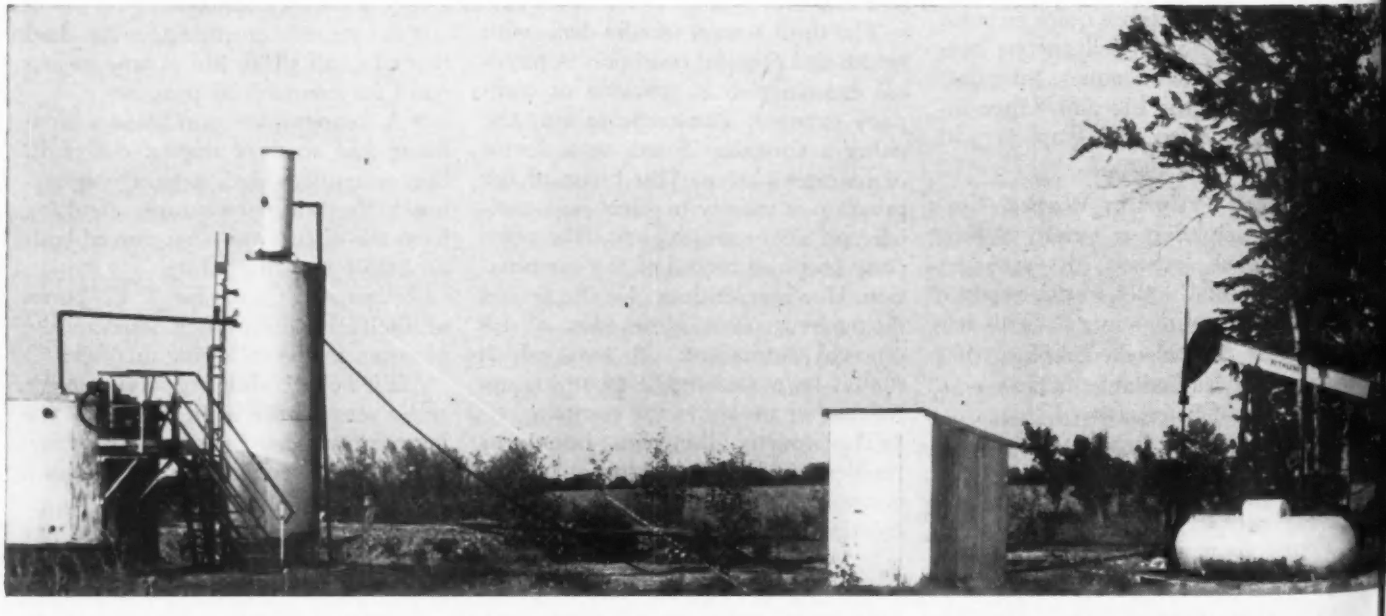
The Shepherd group reportedly has spent nearly $250,000 in research, while American States, which has installed a pilot plant southeast of the town of Nowata, is said to have invested at least $140,000 to date.

Technical research, much of it "classified," is being done by outstanding research organizations, and is being supported by the Atomic Energy Commission.

Dorr-Oliver, Inc., of Stamford, Conn., is doing the research for the Shepherd group, while American States is working with Vitro Corporation of America, formerly Kellex Corporation. Both have "access permits" from AEC which gives them the right to use certain classified information in connection with atomic related research. Dr. J. R. Dunning, Columbia University atomic physicist, who has made valuable contributions in A-bomb development, is also a consultant for American States.

The pilot plant erected by American States is on a 1407-acre lease adjoining water-flood properties acquired several months ago by Climax Molybdenum Corporation, one of the country's biggest mining interests.

Water cycling through oil-bearing sands in this shallow well . . .



EXPERIMENT TO EXTRACT URANIUM from oil field flood waters. Water injected into this shallow oil well in old Nowata field in Northeast Oklahoma is being processed by American States Oil Company.

OIL FLOOD WATERS

. . . because Oklahomans are spending half a million in an experiment

Water used in water flooding operations is tested for uranium content before it is injected into the formation and again on the re-cycle. Tests show that one part of uranium per million parts of water is recovered from the re-cycled water. It takes at least two parts per million to be commercial.

American States submitted samples from Nowata flood waters to University Laboratories, New York City, which in turn submitted them to AEC at Grand Junction, Colo., and other leading research laboratories. They confirmed reports that uranium, thorium and other radioactive minerals were present.

On the basis of reports, all findings were submitted to Vitro Corp. of America, which analyzed 385 samples and completed 854 determinations of uranium content.

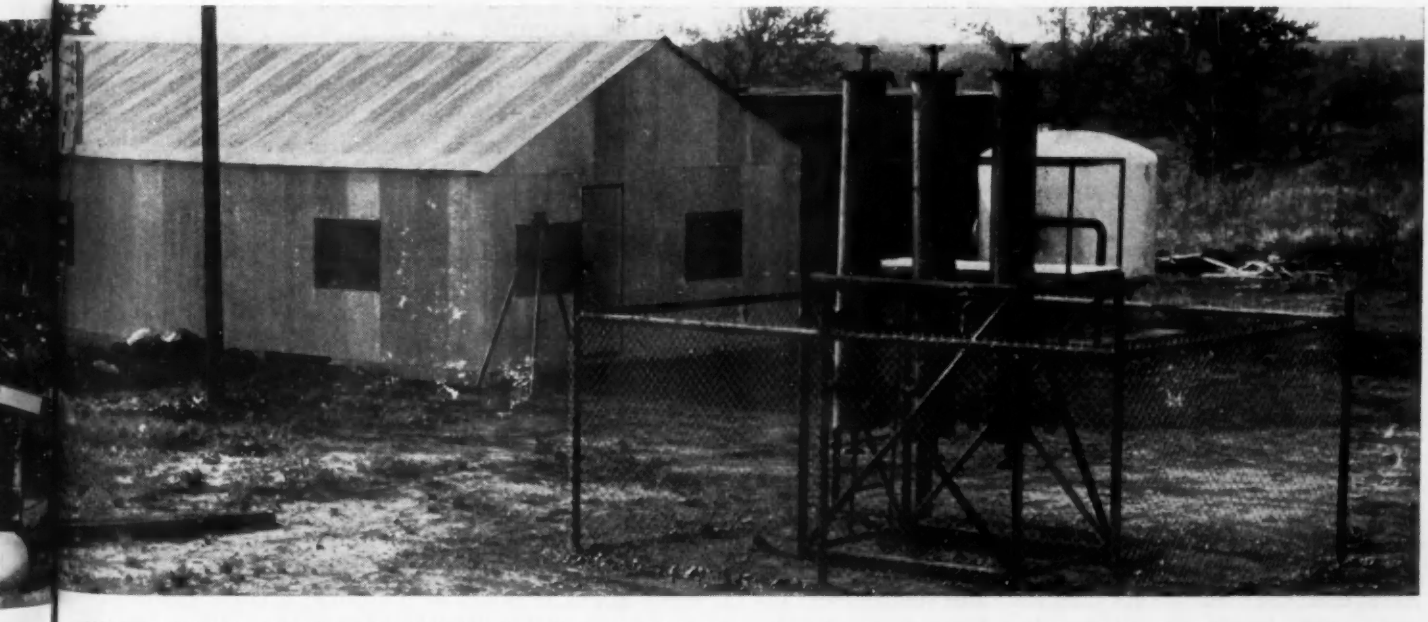
Core samples were also submitted to Vitro Corp., and analysis indicated an average uranium concentration of nine parts per million over a total depth of 378 feet, and 20 parts per million through a 24-foot section. The formations cored were not divulged.

In its report Vitro said through a series of classified methods of extraction in the laboratory, "it removed essentially 100 percent of the uranium." It is now working on the development of a technique to extract uranium from the repressuring waters and filtration sands.

American States, besides erecting its pilot plant, has completed eight water-flood producing wells and 15 water injection wells on its Nowata properties.

Although optimistic of the ultimate outcome, operators concede it will take time and money to work out a commercial process. One operator said that "by 1962" the technique for extracting uranium from oil flood waters will be worked out to the point where he will be able to sell uranium ore to industry on a competitive basis. —**The End**

. . . passes through the filter at right



WATER CYCLED THROUGH OIL-BEARING SANDS in the well goes to the pilot plant located southeast of Nowata. Here, the water passes through the filters shown at right. The building houses other equipment used for the experiment.

25 supervisors say . . .

'These Get the Job Done for Me'

Did you ever wonder how other supervisors get top results from their employes? Here are 25 leadership secrets . . . direct from those who know.

THE BIGGEST JOB of every supervisor or foreman is to obtain the continued and whole-hearted cooperation of the men and women under his direction. Not so many years ago the supervisor with the best record was the one most accomplished at being an iron taskmaster. That day has disappeared.

In our times it takes many skills, ideas and plans for the modern supervisor to fill the role successfully. He must constantly search for methods of procedure which will assure maximum return from payroll dollars spent by the company in his department.

Getting the job done becomes more complicated, requires added strategy and the use of every possible method developed in business today. Recently 25 successful supervisors were asked about their pet methods of getting maximum results from the men and women under them. Here, in brief form, are their answers.

1. Don't be a watchdog

My job is to get things done through people and I never let myself forget it; every step I take is planned toward that goal. The hardest thing I had to learn was that I was not a ringmaster or watchdog over the people in my department. When this clear understanding of my real role as a supervisor came to me results were better and my work was made a lot easier.

2. Give full credit

The most important one thing that has enabled me to get more done in my particular department is, I am sure, a rule of my own which calls for me always making sure that every man gets full credit for any job well done. I've found that the surest way to discourage initiative and extra effort on the part of the people under you is to overlook such things. Even where we have a bonus for such work I've found the men are just as eager for the recognition of what they have attained as they are for that bonus.

3. Lead, don't force

I try to lead rather than force my people to do the job. Whenever a difficult task comes up I've found it cleared away much faster when I stepped in and took the lead rather than pointed it out and told the men to get the job done themselves. It always results in any given job being performed in far less time than under the old method.

4. Never hurt a man's pride

The biggest thing I've learned in being a supervisor is that you have to be constantly on guard to make sure you never hurt any employe's pride. Sure, you can hire the kind of people who have little pride and are never affected by anything you may do BUT they're not the kind of employes who make any supervisor's job easier for him. Pride is a mighty important ingredient in any worthwhile worker—guard it with care and caution.

5. Treat each person as an individual

The one thing I use to keep my department operating smoothly that I think is of most importance is that I keep studying each man and woman to make sure what particular incentives affect that individual the most. I doubt there are any two alike. When I've found the one which gets top results from any individual then I know how to handle that employe. It sometimes takes several weeks to discover what it is but after that there's a lot of smooth sailing.

6. Explain everything

One thing I've found mighty important is to explain everything. Just telling a man to do something or taking it for granted that he understands all about the problem causes a lot of extra make-up work afterwards and sometimes costly slow downs.

7. Set the example

I set the example I want them to follow. No department in any company is any better than the example set by the supervisor. If he takes a sloppy attitude toward the job his men can't help but follow suit. If he sets an example of initiative, love of his work, interest in every job, etc.—his men will always follow suit.

8. Weigh what you say

I've found the most important single thing in getting the job done is to be extra careful of what you say and how you say it. When you do that your words will mean something to the people toward whom they are directed. By doing this you also cut down possibilities for misunderstandings and mistakes.

9. Promote friendly competition

My chief policy is to promote a competitive spirit among the men in my department. Competition always makes for better results even if for nothing

more than to see who can keep his work the cleanest, turn out the least number of errors, or some other element strictly between the men themselves. One word of caution—make sure that's not belligerent competition.

10. Be a good listener

To me it's most important that a supervisor learn to be a good listener rather than completely dominate every conversation he has on the job with the men under him. When you are a good listener you draw your men out—get them to thinking more about the work, developing their own ideas and taking a greater personal interest in the job.

11. Don't play favorites

To me the big thing in getting the job done is in keeping a smooth running operation. I've found one sure way to assure that, is to bend over backwards to avoid playing favorites. Then everyone on the staff works better with the other fellow on the job.

12. Stop trouble before it starts

I try to locate troubles before they break out. Just about 25 percent of my time is spent doing this. Experience has taught me it's a lot easier to patch up something before it comes to the surface than to clean up after it has boiled over.

13. Don't gripe

I always keep a favorable attitude toward the company. What gripes I have against the front office I keep to myself. I've noticed that where supervisors air their dislikes in front of their men the efficiency drops right there and soon the whole group is doing the same thing.

14. Learn patience

Patience is the greatest asset any supervisor can have in handling any man or any problem. Until he learns patience he can't call himself a good foreman. With it you never make snap judgments.

15. Be fair

The toughest job any supervisor ever faces is in disciplining one of the employes under him. It's a point at which he can start a chain reaction which will lead to an explosion of future trouble for him. I make sure I have all of the facts before I ever discipline any employe. That's kept me from making mistakes which could have disrupted my whole department later on.

16. Praise good work

My pet method of getting the job done is to find every opportunity I can to praise individual employes for their work. It accomplishes wonders. But it can be dangerous if overdone; you have to learn the proper balance and adhere to it.

17. Avoid prejudice

I'm careful to avoid prejudice against any individual employe. If he has feelings, traits or actions I dislike I ignore them completely as long as that individual does a good job. I've seen too many cases where supervisors let prejudices against certain employes ruin all of the other good things they have done and completely mess up their departments.

18. Build the man's job

To me one of the most important things you can do is to never overlook an opportunity to build up a man's job in his own estimation. The man who is proud of his job always does more for you with less trouble.

19. Accentuate the future

I keep building on each employe's future with the company. I've found the men under me have to have goals toward which to work hard; without them they never have the incentive to do anything extra. I never overlook an opportunity to do this.

20. Avoid destructive criticism

A supervisor has to dish out criticism; that's one of the reasons he's in his job. But I've found there are two ways to do it, i.e., constructively or destructively. The former gets the best results. Whenever I criticise my employes it's done constructively . . . and I've always had good results with this approach.

21. Show appreciation

Show an interest in and appreciation of his work; that makes him a better man and easier to handle. Confine your efforts to keeping him working and he'll use every dodge he can think of to keep from doing anything extra.

22. Discuss job problems

My pet rule is to always discuss every job problem with the men involved. Following it has done more for me in my department than anything else I've ever tried to do. You get more willingness to do something extra from your men when they have a chance to help you work things out.

23. Stress individual initiative

One of my pet methods of getting the job done in my department is to give my men things to work up on their own. That keeps them from being mere machines. It keeps them alert. It enables them to have that something extra when they have to think out a problem all by themselves during an emergency.

24. Don't make false promises

I carefully avoid making promises that I may not be able to fulfill. I've found that's a bigger source of resentment by employes against their supervisors than anything else. When it involves the company I make sure first it will be delivered before I promise my men anything.

25. Be consistent

I try to be consistent in my approach to all of the problems concerned with my department. I've found the men are then never afraid of my moods or uncertain about what I will do. It also helps them work out a lot of problems on their own.—**The End**

Which man are you?

He CANNOT produce effectively.

He CAN produce effectively.

Nervous Tension Can Be Controlled

The ability to recognize and control excessive tension in personnel is the key to increased productivity, health and happiness.

EXCESSIVE NERVOUS tension is a growing problem in modern industry. If allowed to go unchecked the following physical reactions appear among all levels of personnel:

- Irritability.
- Reduced efficiency.
- Chronic fatigue.
- Varied physical disorders—imagined and otherwise.

On the other hand, the ability to recognize and control excessive tension can contribute to the productivity, health and happiness of personnel in any industrial operation.

Industry is fast becoming aware of the importance and potential of successful tension control for its employes. As time goes on and scientific methods are applied by still more companies, it may well develop that they will have far-reaching effects in improving the business and personal life of large segments of the working population.

What is excessive tension—and how can it be curbed?

All during the day, everyone engages in a series of activities that involve the contraction of muscles throughout his body. If these muscles are maintained in a state of abnormal tone—tension—for any reason, the output of effort in the conduct of the day's work is correspondingly increased and may be excessive.

The fatigue that results from overstimulation sometimes is not apparent until many people find themselves in a state of general fatigue. Tensions built up during the day continue, and often the cares of business go home with them.

Recognizing the importance of tension control to its employes in both their work and home life, Ethyl Corporation two years ago began to investigate the possibilities of doing something about it under its industrial relations program. Since that time, Ethyl, with gratifying results, has provided instruction in tension control for some of its executives and supervisory employes.

The method employed has been widely used for more than 35 years. It was developed by Dr. Edmund Jacobson, of Chicago. Since it was first introduced, the method has taught thousands of people how to operate their bodies so that they can enjoy calmer, happier, healthier and more profitable lives.

Other doctors and laymen have been trained in the successful use of Dr. Jacobson's methods, and he and these men have taught it to many men and women of various ages and occupations. In addition, U. S. Navy air schools have used the methods with good results in training more than 15,000 cadets.

People who have been helped by the methods endorse their use enthusiastically. The president of a nationally-known business concern says that after he undertook the training he achieved a degree of tension control he had never thought possible.

A high-ranking officer in the Navy tells of his experience: "Before World War II, I suffered a complete breakdown. My doctors told me I would

have to retire and work at one-third speed for the rest of my life. But I learned of this method of easing tension and worked at it seriously. During the war, I was able to work 12 or 14 hours a day in Washington, board a plane for a long trip, turn myself out like a light, and get off at my destination refreshed and ready for another long day. The ability to achieve tension control not only changed my life, I feel it saved it."

Navy air cadets who took the course reported help in the ability to sleep longer and more soundly; to do better in academic and physical training; to be more relaxed before and during competitions; and to do a better job of flying. At the same time, the total number of days lost from injuries among cadets receiving the tension control training was reduced 38 percent.

The scientific system of tension control requires full participation in developing new habits, but if it is followed faithfully the step-by-step procedure can bring impressive results. The more exactly it is followed and the longer it is pursued, the more benefits it provides.

In approaching the subject, it is important to understand that tension control is achieved by gaining muscular control. When a businessman learns to relax all his muscles except those needed to perform the task at hand, he is able to accomplish more work and be less fatigued at the end of the day. He will be happier in his job and in his home life. He will sleep better and his entire life will be better.

Many businessmen, of course, are tense without realizing it. When their legs are crossed, their forehead wrinkled, sitting or standing stiffly, or when the muscles in their neck and shoulders are contracted, they are not completely relaxed. Similar small tensions, of which many men are totally unaware, constantly tighten the muscles all day long, building up pressures that lead to mistakes and other difficulties and increasing fatigue.

A review of a few physiological principles help explain why this is so. If a muscle is tense, it is contracted, and therefore it is in use. Even the slightest mental or bodily activity includes the contracting of some muscles. But muscle contraction also includes nerves. About half of the nerves in the body are used to alert the muscles or carry messages from the muscles to the brain. The activity of the nerves, electrical in nature, moves along the muscle like a wave, with a rapid discharge rate. When this discharge rate is greatly increased, there is high nerve tension and the muscle becomes rigid.

Since the nerves are in action whenever a muscle is tense, it follows that the relaxing of the muscle includes the easing of nerves. The relaxing of any set of muscles will begin to stop the spread of nervousness to the other areas of the body and thus restore calmness.

Practice is an essential part of the tension control methods. Those following them are urged to fix a particular time of day for practice. At least a half-hour is recommended and an hour is much better.

The practice consists of tensing and relaxing various muscles of the body. These manipulations teach you to become aware of tension, to recognize it whenever and wherever it occurs in your body, and to control it effectively. A large part of each practice session is also spent in complete relaxation.

Skill at tension control is put to a practical test, of course, in everyday activities. Differentiating between the muscles that must be tense to carry out necessary activities and those which are not needed and consequently should be relaxed, and relaxing them, is the goal.

In its awareness of the importance of tension control to individual employes, Ethyl Corporation in 1953 examined Dr. Jacobson's methods. As a part of this investigation, which was headed by C. R. Holton, Ethyl's industrial relations director, ten of the company's top executives took Dr. Jacobson's course in tension control. The results were favorable and it was decided to make the program available to more Ethyl personnel.

Accordingly, Ethyl's manager of training was trained as a qualified instructor. Since then, he has conducted three ten-session courses in tension control for selected supervisory employes in Ethyl's New York offices.

The interest in these courses is evidenced by the answers to questionnaires sent to participants at the conclusion of each. Almost without exception, they reported beneficial results. The degree of skill in relaxation which they acquired varied considerably, depending upon natural ability to relax, which varies with individuals, and the amount of practice which each individual devoted to learning the subject.

Some reported that the mere ability to recognize tensions, which they had not realized existed before, was beneficial to them. Others reported ability to sleep more soundly, greater efficiency in their work, and some reported less friction and better relationships with others, both in their business activities and family life.

Many people exert more muscular effort than they need . . . they "try too hard." When they learn to ease up, they produce more effectively . . . and are less tired at the end of the day.

Although this was an abridged training program especially devised for Ethyl Corporation, its simplicity and ease are such that it can readily be extended. Just how far the program will be expanded in Ethyl Corporation is now under study.

Meanwhile, Ethyl's experimental program has created an interest in the subject of tension control among other companies. A nationally-known merchandising organization has engaged Dr. Jacobson to train one of its men as an instructor and has instituted its own program. A commercial airline is studying the possibility of giving tension control training to its pilots. Two leading oil companies have asked for fuller information on the subject with the thought of making it available to some of their employes. Inquiries have also been received from a number of other business and industrial firms.

—The End

Don't Overlook Possible Tax Savings

Can you answer these questions?

- **Is it permissible to show a capital gain in selling one oil pay zone while retaining all other horizons?**
- **Can a capital gain treatment be applied to selling gas rights while keeping oil rights?**
- **How can tax savings be made when a person agrees to drill and equip a well in exchange for an interest in the lease?**
- **When can an "in-oil payment" be accorded capital gain treatment instead of being considered ordinary income?**

By JOHN F. Y. STAMBAUGH,
Frazer and Torbet,
Tulsa

THE OIL MAN of today is confronted constantly with the tax aspects. In order to be on the safe side, decisions should not be made until the tax practitioner has been consulted to determine the best method of approaching the matter in order to bring about the greatest tax savings to all parties involved. It would not be feasible to attempt to discuss all topics of any one phase of oil and gas taxation in this article. It is felt that most oil men are acquainted with the tax aspects connected with percentage depletion, the right to expense intangible drilling and development expenses, and the necessity of capitalizing lease and well equipment. In this article the writer will attempt to explain a few of the more complicated aspects of oil and gas taxation in order that the oil man may gain a better understanding of these transactions.

Property Definition. Frequently a taxpayer may wish to sell a particular sand or horizon in a property but wishes to retain the mineral interest in the remainder of the property. Under the 1954 Revenue Code a property is defined as "each separate interest owned by the taxpayer in each mineral deposit in each separate tract or parcel of land." This definition follows the terms used in GCM 22106 (1941-1 CB 245) which disclosed the commissioner's viewpoint as to the meaning of property.

Thus stated, a person may sell a particular horizon on a given lease retaining all other levels, and be accorded capital gain treatment for the proceeds derived from the sale of the one particular horizon. In Edward J. Hudson et al v. Commissioner (11 TC 1043), the Tax Court stated and was upheld by the Fifth Circuit, that "there are separate depletable interests in various hydrocarbons contained in gas in place, provided they would be extracted without resort to a manufacturing process."

Following this line of reasoning one might sell the gas rights in a given sand while retaining the oil rights thereto with capital gain treatment accorded to the transaction. However, the Revenue Service did not acquiesce to the Hudson case saying, "that an economic interest in oil and gas in place is not capable of division by contracts so as to give one part all, or part of, the liquids exclusive of gas."

Thus any person seeking to sell gas rights while retaining oil rights in a particular horizon should not do so with the idea that the transaction will result in a capital gain consequence without being contested by the Revenue Service.

Capital Gain vs. Ordinary Income on Sale of Lease. Oil men are frequently confronted with the problem of whether leases were held primarily for sale to customers or for use in a trade or business. The importance of this distinction is due to the capital gains treatment available to the taxpayer for sales of property held for use in a trade or business. In the event the taxpayer is an individual, his tax on a gain may be divided by two before applying the individual's tax rate, with a maxi-

"Many times the tax practitioner learns of his client's contract on a specific transaction only after it has been completed and advice is valueless"

mum tax of 25 percent of the gain reported. A corporation likewise pays a tax of only 25 percent of the gain on the transaction.

However, if the taxpayer has a sale of "goods held primarily for sale to customers," the gain is taxable as ordinary income. Several facts are involved in determining the classification of the property. The recent case of George S. Engle V. Commissioner, Tax Court, 1954, (13 TCM 1954-61) stated the following factors in determining the tax treatment of the transaction:

- Continuity and frequency of sales.
- Activity of the seller or those acting on his behalf.
- Purpose for which the property was acquired.
- The purpose for which it was held.

The court further states that the factor given the most weight is the purpose for which the property was held during the period in question. The Court held that since Engle did not purchase any wildcat lease or producing lease for the purpose of resale, that after oil was found he always held the lease for income, that he was not a licensed broker and did not solicit purchasers, and that the number, continuity and frequency of sales were not of such a character as to indicate that they were in the course of his trade or business; that the sales under question did not constitute sales of leases held for sale to customers and should be accorded capital gains treatment under Section 117 (j) of the 1939 Revenue Code (Sec. 1231 of 1954 Code).

Engle had sold six producing lease interests, two royalty interests, and several wildcat lease interests during the three year period under review. The oil operator should bear these factors in mind if he occasionally sells oil interests in order that he may obtain the maximum tax advantage available to him.

Allocation of Costs Between Leasehold and Equipment. Many times the tax practitioner learns of his client's contract on a specific transaction only after it has been completed and advice is valueless except for future deals. Sometimes a small detail in a large contract may save the operator tax dollars if the advice is received prior to the completion of the contract. Such a case results when a person agrees to drill and equip a well in exchange for an interest in the lease. In illustration let us take a hypothetical case where "A" has the working interest in a leasehold. "B" agrees to pay "A" the cost of drilling and equipping a well on the lease in return for a three-fourths interest in the well.

The tax treatment of "B's" investment is substantially different if "A" retains a one-fourth working interest in the lease instead of a one-fourth overriding royalty. Assume that the drilling and completion costs total $16,000, equipment costs are $10,000 and that monthly operating costs are $200. If "A" retains a one-fourth royalty, "B" is entitled to deduct all the drilling and completion costs. He may capitalize and depreciate the full value of the equipment, and will pay the full $200 monthly operating costs.

However, if "A" retains a one-fourth working interest in the lease and thus pays $50 per month of the operating costs, "B" will be entitled to expense only $12,000 (¾ of $16,000) of the drilling costs and may capitalize only $7500 (¾ of $10,000) of the equipment and recover his costs through depreciation. The remainder of the drilling costs, $4000, and equipment costs, $2500 must be capitalized and recovered through cost depletion. On the face this does not appear to be a disadvantage to "B" as he still gets to recover the additional $6,500 through depletion. However, when computing depletion, the person is allowed to deduct the greater of statutory depletion, 27 percent of gross income from the lease, or cost depletion of leasehold costs. Assuming the well is a profitable one, "B" will be able to claim statutory depletion each year. Leasehold costs will be lost for tax purposes.

Thus "B" will not be allowed the immediate deduction of $4000 drilling costs and the prorated deduction of depreciation on the $2500 lease equipment. In return he will save the $50 per month operating costs, but the tax savings on the additional deduction and depreciation which represent money already spent will more than compensate for the added expense in the subsequent years which will also be deductible for tax purposes.

The above treatment of the costs, where the working interest is retained by "A", is prescribed in GCM 22332 (1941-1 CB - 228) which provides that there may be deducted only a proportion of the interests in the lease so acquired. Thus it pays to seek advice prior to entering into the agreement rather than after the contract has been closed.

Oil Payments. Much interest is always centered around the possible treatment of oil payments sold as a capital sale transaction, thus allowing the seller to have the advantage of capital gain treatment when filing his income tax return. The Internal Revenue Service stated in GCM 24849

About the Author

JOHN F. Y. STAMBAUGH was born in Archbold, Ohio, and moved to Oklahoma in 1918. He attended the University of Oklahoma receiving a B.S. degree in business in 1936 and the same year went into public accounting work with E. W. H. Falter of Oklahoma City. In 1940 he joined Haskins and Sells in Houston. Two years later he joined the U. S. Navy and served until 1946. After leaving the service he went to Tulsa as manager of the Frazer and Torbet office there and the following year became a partner in the firm. He specializes in accounting and tax problems in connection with the oil and gas industry.

"A great deal of controversy exists between the courts and the commissioners' viewpoints in regard to oil taxation payment. No clear cut rule has been adopted . . ."

(1946-1 CB 66) that consideration received for the assignment of a short-lived "in-oil payment right" carved out of any type of depletable interest in oil and gas in place and not pledged for future development of the same lease is ordinary income subject to the depletion allowance in the assignor's hands.

I.T. 4003 (1950-1 CB 10) further clarifies the "short-lived" terminology mentioned above by providing that the assignment of any "in-oil payment right" (not pledged for development), which extends over a period less than the life of the depletable property interest from which it is carved, is essentially the assignment of expected income from such property interest. Thus stated, an "in-oil payment" may be accorded capital gain treatment only when the right constitutes the entire depletable interest of the assignor in the property or a fraction extending over the entire life of the property. Where the assignment of the "in-oil payment" is donative, the transaction is considered to be an assignment of future income which is taxable to the donor as depletable income at such time as the income from the assigned payment right arises.

Three cases recently decided, have caused considerable comment due to the manner in which the court held. In Lester A. Nordan et ux v. Commissioner, August 31, 1954, Tax Court (22 TC —, No. 137), the following facts were presented: Nordan executed a deed to the Central Christian Church of San Antonio, Texas, wherein he conveyed an undivided one-eighth interest in oil and gas in place until the donee received $115,000; at such time as the amount was received by the donee, the interests would revert to the donor. The fair market value of the property at the time of the gift was $111,925.95, which Nordan claimed as a charitable deduction on his 1949 income tax return.

The church sold the property to a third party in January, 1950, for $109,825, the third party received the $115,000 representing the production in 1950. The Commissioner added $109,825 to Nordan's gross income in 1950, allowed a charitable deduction of a like amount, and also deducted allowable depletion of $30,201.87. The question raised in the tax court was "whether the Commissioner erroneously disallowed a contribution of $111,925.95, the fair market value at the time of the assignment, as claimed by Nordan." The tax court held that as the property had no accrued income as of the date of gift and the income resulted from production subsequent to Nordan's conveyance, that the taxpayer was allowed to claim his contribution at the time the donation was given. Thus the court says that Nordan made a transfer of the property itself and not merely the right to future income, which makes the fair market value when the transfer is made the basis for the deduction.

Another case in point as to the wide variance of opinion between the courts and the Commisioner in this matter is Hawn v. Commissioner, December 23, 1954 (Tax Court), (23 TC —, No. 64). Hawn possessed an oil payment with a balance of $854,993.25 with a zero tax basis. He transferred to C, a general contractor, a carved out oil payment in the amount of $120,000 in consideration for which C agreed to construct a house for H. At the time of the transaction it was anticipated that the oil payment would be liquidated within two years; actually C received all compensation in approximately nineteen months. Since the oil payment was a capital asset in H's hand, he reported the sale as a capital gain on his 1949 income tax return. The Commisioner disallowed the capital gain treatment and adjusted H's return to include the $120,000 as ordinary income with $33,000 depletion deduction allowed. The commissioner contended that since the consideration received for the oil payment was not pledged for future development of the property, H received ordinary income subject to depletion. However, the Tax Court held that H consummated an assignment of "property" instead of an assignment of future income and allowed the capital gain treatment, thus over-ruling the commisioner and holding contra to GCM 24849 mentioned above.

Still another case recently decided which controverted the Commissioner's position was Caldwell v. Ellis Campbell, Jr., Collector, January 12, 1955 (5th Circuit) (55-1 U.S.T.C. Par 9148). In this instance Caldwell owned certain royalty interests out of which he transferred to the D. K. Caldwell Foundation, created and controlled by Caldwell, oil payments in the amount of $1,445,100 in consideration of $3,400 cash and notes aggregating $1,005,000. The oil payment had a fair market value of $489,433. Caldwell reported the gain from the sale as capital gain taxable upon the installment method of accounting as the notes came due. The commissioner contended that the transaction constituted assignments of anticipatory income and thus was taxable at ordinary rates after deducting the depletion allowance.

Caldwell paid the deficiency assessed and filed claim for refund. In the District Court opinion, the Court held the transfer not to be a bona fide transaction and that the value of the notes as of the date of the transfer was taxable income. This opinion defeats itself since in the event the transfer was not bona fide, then no transaction occurred which could bring about taxable income of any nature. On appeal to the Fifth Circuit the case was reversed and sent back for new trial on the premise that the government's position is no more than an attempt to distinguish the transfer from a property standpoint from the transfer from a tax standpoint as far as royalties and carved-out oil payments are concerned.

As can be seen by the decisions in the three cases mentioned above, a great deal of controversy exists between the courts' and the commissioner's viewpoints in regard to oil payment taxation. No clear cut rule has been adopted which can be set out as a guidepost upon which a person may safely contract. It seems at this time that future legislation on this matter might possibly be needed before the situation can completely be reconciled to the satisfaction of all parties concerned.

—The End

Pick YOUR Number –Win New Friends For Your Business!

Here is a simple way to make new friends for your business—and at the same time perform a real service for your industry.

You may ask "does my industry need help?" The answer is *yes*. For today it is urgent that the public appreciate more thoroughly the job oil men do. People must continue to feel the oil industry can best serve *them* by remaining privately managed, fully competitive, and free from excessive governmental control.

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Joining in this effort will mean real help for your industry. But *you* will also profit. You'll enjoy the great personal pleasure of working with other members of your community. It will mean winning many new friends for yourself—and for your business as well.

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How to Get Full Value From Internal Auditing

- **Carefully planned internal auditing programs can make dynamic contributions toward improved management.**
- **Work should go beyond verifying figures and check up on fulfillment of policies and plans.**
- **Critical analysis of procedures will eliminate wasted effort and produce efficient results.**

By E. E. FAUCHIER
Manager, Administrative Department, Stanolind Oil and Gas Company, Tulsa

THERE IS A significant and increasing interest throughout industry directed toward the improvement of industrial organizations and the handling of business transactions and management problems in a more effective manner. This increased interest by management and the proper recognition of its responsibilities can only lead to constructive revisions in management thinking, planning, and practices.

Regardless of the size or kind of an organization structure, there are always three primary functions present:

1. **Planning** involves deciding upon the primary objectives of the business and the development of an appropriate organization structure, sound and practical policies, delegations of authority, adequate methods and procedures, operating programs, and the necessary controls to assure that approved plans are being properly carried out.

2. **Execution** involves the decisions and actions required in accomplishing the objectives of the business, including the carrying out of approved plans.

3. **Control** involves all actions, reports, etc., as necessary to ascertain that approved plans have been, or are being, properly executed.

Of importance in the major tools of management is the **internal auditing** function. It is an important control media for management to review the results of plans. However, trends in modern management philosophies demand more than ever a change in internal auditing scope and programs. This is a challenge requiring greater ingenuity and planning for internal auditing, which, if accepted, should result in versatile internal auditing programs that can make dynamic contributions toward improved management controls.

In the internal auditing function, just as in any area of organization, one must have a sound plan or program to operate with any degree of efficiency.

Internal auditing should not be burdened with, or attached in any way to, the current routine functioning of a department.

An individual department of a company should not be singled out for auditing to assume some of that department's normal functional responsibility for correct performance of work.

If internal auditing performs current routine work of other functional units, it can frequently add up to a full-time job for part of the auditing staff, which precludes full utilization of the staff for the real purpose for which the auditing is established. Unless the auditor enjoys this status of independence with respect to other departmental activities, he is not in a position to provide management with the best coverage and utilization of his services and is subject to being retarded in reporting the full facts.

The program followed by the auditor is far more effective if it is well planned and organized.

Every component of the program should be critically analyzed from an objective viewpoint. It should have a far greater scope than what may be defined as a financial audit. It is something beyond verifying cash receipts and disbursements, financial statements, account analysis, etc.

It is not intended to infer that there is no financial auditing involved. Internal auditing should be broader than that. For instance, definitely, there should be reviews set up to determine compliance with established policies, delegations of authority, procedures, and other administrative controls.

Worth to management will be strengthened if the auditing procedure, carefully examined in the light of an objective or purpose, is of value to management with respect to control. Critical analysis of procedures will eliminate wasted effort, producing efficient results.

There is another very important

About the Author

E. E. FAUCHIER, Stanolind Oil and Gas Company's administrative department manager, joined the company in 1933 at the Tulsa general offices. A Kansas State College commerce graduate in 1930, he had been with Arthur Young & Company, Tulsa public accounting firm, before joining Stanolind. In 1939 Stanolind organized its internal auditing department. Fauchier was made auditor in charge and in 1951 became assistant administrative coordinator.

criterion which supports well planned auditing programs. That is the economic aspect. It is obviously impossible to measure the results in dollar values. Too often we appraise on this basis. Actually, there are many benefits of an intangible nature which can be only generally evaluated. In many instances, these may be the most important and profitable features in the auditing program. This refers to a system of internal control, compliance with established policies and procedures, safeguarding of company assets, and suggestions for improvement.

This phase of internal auditing is becoming increasingly more important to our present-day management. Geographic expansion of operations, delegation of substantial authority from general office headquarters, etc. impose a greater alertness on the auditor if he is to keep in step with changes in management philosophy.

Periodic visits by the auditor to operating locations provide him with an ideal opportunity to review compliance with policies and procedures and to suggest improvements. How well he does this determines his relative usefulness to management. Because of his regular visits, he is probably in one of the most favorable positions in the organization to make this review. Reasonable assurance that administration of policies, procedures, delegated authority, etc. is in accordance with management's plans can be best obtained through inspection or review. This part of such program, if carefully considered, is not only invaluable to top management, but also is of material assistance to operating personnel at lower levels of management.

Management personnel closest to the actual operations are most familiar with the problems. The internal auditor can ascertain from such personnel the practical operating aspects of established policies, procedures, etc. with respect to day-to-day operations, including changes which may be suggested for improvement. Such information is of assistance to higher levels of management in instituting or revising policies and practices, resulting in improved business operations.

This is one of the greatest possibilities for improvement in internal auditing which cannot be evaluated in tangible amounts, but which can go far in eliminating the feeling toward an auditor that so often is reflected by the courtesy handshake—glad to see you—but wondering how long you will be around and glad when you are gone.

In developing an auditing program there is another very important consideration. That is, to what extent the review will be made of the respective features provided under the examination. There are, of course, many ways of making this determination. It may be on a percentage of the transactions handled during the period under review. It may be a check on all matters related to the transaction for a month, or a combination of both, etc. Other aspects in this regard are potential losses to the company, vulnerable spots for lavity, non-compliance with established policies, procedures, etc. Regardless of the determination as to coverage, it is, at best, only a guide based on experience and judgment which serves as an indicator to the auditing staff in developing and concluding the results of the examination.

The pre-audit of transactions, such as cash disbursements, can easily work to a disadvantage in establishing coverage for the auditing program, by submerging auditors with routine detail, leaving little time for constructive auditing.

The **post-audit** more nearly approaches the kind of auditing that will provide management with beneficial results and information. This type of auditing lends more discretion as to what should be examined, how the verification will be made, extent of coverage, etc. It provides an opportunity to broaden the scope of auditing activities. This is important since the auditing staff is usually limited.

In establishing coverage under a post-audit, features of the examination can be expanded to generally touch on any action taken in the company that has a bearing on the transaction. This would likely be impractical, because of the time element, under pre-audit system. The post-audit method of analysis provides better opportunity for spotting any weakness in controls and procedures.

An effective auditing program should be reduced to writing, to serve as a guide or audit manual for the periodic reviews. It is not intended that the auditor be limited in his review to the extent provided in the manual, but rather he must use judgment in extending manual requirements made necessary by disclosures during the examination. A manual is a guide as to what is expected, eliminates misunderstanding, is conducive to higher standards for auditing, and facilitates the auditor's activities, and avoids his overlooking important aspects of the program.

Other considerations of importance in an auditing program which should be observed, briefly are as follows:

- Clearly define the objective for each feature of the audit.
- Determine a reasonable period for coverage, such as monthly, semi-annually, etc., and the extent of the review for such period.
- If reference can be made to company records, policies, and procedures, it is beneficial. It assists in not overlooking some important aspects of the verification.
- Have your manual flexible: adaptable to change without delay. Keep it current.

One of the greatest contributions internal auditors can make in improving relationships with management of the location being reviewed is to sincerely discuss their findings with local management at the conclusion of the examination.

Of course, there are exceptions of a highly confidential nature that should be made known only to top management, but aside from these the results should be disclosed to local management.

Exceptions disclosed by the auditor should be promptly concluded. It destroys the effectiveness of a progressive auditing program to delay disposition of exceptions unnecessarily. By discussing the results of an examination, many exceptions can be concluded at the management level being examined. Such results can be included in the report to higher management, thus eliminating delays in disposing of exceptions and in advising higher levels of management of the findings.

Another advantage in discussing results of audits with local personnel is that one can get an expression from them on items which require action at higher levels. This avoids referring such items back to the audited locations and delaying conclusions. Man-

agement today is approaching a greater realization of the value of participation by the various levels of management in developing improvements and affecting changes. This situation calls for action on the part of the internal auditor if he is to progress with the times. He needs to realize that maybe it isn't really necessary to limit disclosure of the results to a respected few.

Minor routine errors should be eliminated from the audit report. Calling them to the attention of the local management for correction would seem sufficient. Otherwise the report may be so detailed that top management will never read it, but assign an assistant to digest and briefly report on important exceptions.

The report should be informative, covering the important matters, and including findings which are in need of corrective action. Realize that the report is designed as a tool of management, a medium for control.

These points serve only to illustrate the importance of effectively reporting back to management. When reporting exceptions, give all related facts. It is essential for management's decision. Avoid the delay and embarrassment of having to obtain more information.

Internal auditing to be of real service to management should, by some medium, make known to the board of directors the activities and results of auditing, periodically. There should be some presentation which briefly and concisely reports the accomplishments. This presentation should cover the important exceptions or recommendations and the status or conclusion as of the date of the report. Minute detail should be eliminated if the report is to be read.

Implications of changes in management today are moving forward steadily. There are new techniques, expanding organizations, electronic data processing machines, etc., all of which challenge the wisdom and skill of the internal auditor. Management looks to him for ever-increasing service to assist in this progress. This situation presents him with a challenge for unlimited opportunities to serve management. **—The End**

Californians Vote in November On Oil–Gas Conservation Bill

CALIFORNIA WILL VOTE in the November general election on a proposed "Oil and Gas Conservation Act." This was assured April 12 by the filing of petitions signed by 475,000 people, or more than the 322,429 signatures required by law to bring the legislation before the voters.

The measure would authorize compulsory unitization and repressuring of California oil fields if at least 75 percent of the operating and royalty interest owners in a field signed a unitizing agreement. An oil and gas conservation commission composed of three appointed members would replace the present state supervisor of oil and gas. The commission would have authority to establish well spacing units in any pool discovered after the act becomes effective.

Supporters of the measure claim it would assure maximum recovery of oil and gas and prevent waste. They say it would not involve curtailment or proration of production to market demand and would not seek to influence prices to consumers. They assert that California's present voluntary conservation has not been fully effective. Richfield Oil Corporation proposed the measure last January. It has been approved by most of the other major companies and some independent operators.

The proposed law is opposed by Union Oil Company of California as well as some independent operators. The opponents declare that the sponsors wrote the bill without consultation with the great majority of California oil operators or with the public. They charge that the sponsors deliberately by-passed regular legislative procedures, where the bill would have to undergo the scrutiny of committee hearings and floor debate. Enactment of the bill would cause the industry to be dominated by a few major companies, the opponents declare. They assert that the measure would substitute bureaucratic control for a successful system of voluntary cooperation, backed by adequate laws. The opponents add that one-fourth of California's oil production comes from voluntarily unitized pools and properties operating under cooperative agreements.

Locomotives Test Residual Fuel

INITIAL TESTS in the use of residual fuel oil in conventional diesel railroad engines point toward increasing use of this fuel by the nation's railroads. Cooperative efforts of Union Oil Company of California and Southern Pacific Company on one of the world's "most challenging" sections of railroad, over the Sierra Nevada Mountains between Sacramento and Reno, have shown that a dual-fuel system automatically controlled according to load and speed conditions will give excellent service and performance and, under high-load conditions, can work more efficiently.

Early tests showed that residual fuel alone presented two problems not encountered with diesel fuel. Under low-load, or low-speed, due to insufficient heat of combustion, residual fuels did not burn efficiently. Also, at low temperatures, residual fuel tended to thicken and present problems in pumping through the fuel system. Installation of dual-fuel equipment and tanks, the latter heated by a heat exchanger system using engine jacket water, has overcome these problems. The dual-fuel equipment is relatively inexpensive, easy to install and adjustments are simple.

It is reported that, to date, all tests in this significant development point toward eventual success. Southern Pacific has converted 12 or more of its diesel units to dual fuel and is in the process of changing more. Two other major railroad lines also have made significant progress in this type of conversion also.

Since residual fuel gave a surprisingly good performance under high-load and high-speed conditions—which account for about 85 percent of a locomotive's total fuel consumption—this conversion of diesel equipment could mean an important return of residual fuel to railroad use.

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PACKAGED AIR COMPRESSOR

A rugged packaged compressor for heavy-duty field service

The new Clark Air-Pac is a completely automatic, 500 horsepower compressor station specifically designed for Air and Aerated Mud Drilling.

With the Clark Air-Pac, the operator is assured of an air supply that is completely dependable and as rugged as the rest of his rig. Work stoppage, which often occurs when light, multiple units are used, is eliminated. The Air-Pac is economical to operate too. In most applications there is ample power available from the rig to drive it. It's also easy on manpower. Being automatic, it operates unattended! And when you move to a new site, it's one unit to move—not a dozen.

The Balanced/Opposed vibration free design of the compressor means you can set the Air-Pac on timbers and forget it.

The Air-Pac uses a special, belt-driven, four stage Clark CMA-4 Balanced/Opposed compressor. The compressor, together with a heavy-duty vertical air flow radiator for intercooling between stages and lube oil cooling, is mounted on a rigid steel skid. Discharge pressure can be set and maintained at any level between 500 and 1,500 psi. Pneumatic controllers regulate both capacity and horsepower *input*—automatically.

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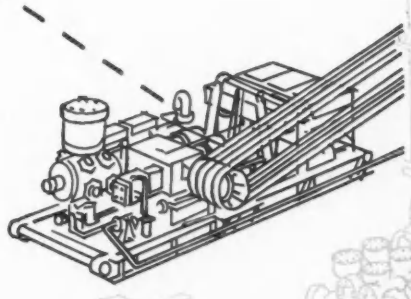

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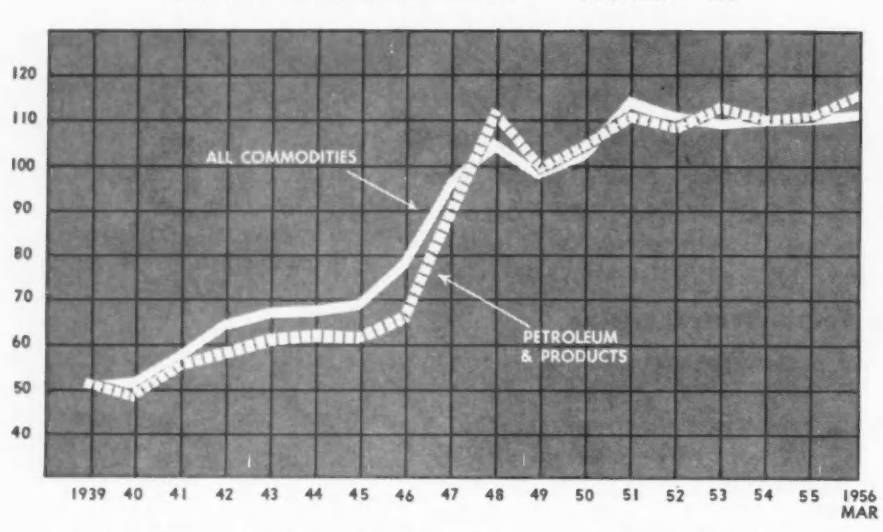


Higher Prices in General Would Support Higher Oil Prices

Prices of petroleum and products traditionally stick close to the trend of prices of all commodities in the aggregate. All commodities are likely to increase around midyear. If they do, oil prices probably would, too.

General Wage-Price Hikes May Push Oil Prices Up

By L. J. LOGAN, World Oil Staff

Will crude oil and petroleum product prices be increased in the near future? The answer to this often asked question may be determined mainly by the future trend of prices of commodities in general. If prices in general go higher, as they now seem likely to do, then prices of petroleum and products probably will go up, too.

As shown in a chart and tables herewith, prices of oils in the past have stuck very close to the trend of prices of all commodities in the aggregate.

Since last fall, prices of all commodities combined and prices of petroleum products have been moderately increasing. Oils have increased somewhat more than other commodities.

If prices of oils are to increase substantially in coming months and hold at the higher levels, they probably will do so only with the support of similarly higher prices of other commodities.

The stage may be about set for this to happen. It is indicated that a new general wage-price increase may be sparked at midyear by the steel industry. Steel wages are expected to be raised 15 to 20 cents an hour and steel prices about $10 a ton. Subsequently, wage and price increases may occur in many other lines, as in the past when steel led the way.

Higher prices for oils around midyear might be in line with the trend of prices of commodities in general.

Higher prices for oils would be justified by past and prospective increases in costs of labor and materials and the increased costs of finding and developing oil reserves.

Heretofore, in spite of higher costs, prices in the oil industry have been held down, partly because of the pressure of ample supplies of domestic and foreign crude. However, continued increases in costs now threaten to curtail supply. Higher prices for oils now seem more necessary to bring forth adequate supplies for the future.

Index of Wholesale Prices

(All Commodities vs. Crude Petroleum and Petroleum Products.)

Source: U. S. Bureau of Labor Statistics. 1947-1949 = 100

YEAR	All Commodities	Crude Oil & Products	YEAR	All Commodities	Crude Oil & Products
1926	65.0	98.1	1942	64.2	58.7
1927	62.0	71.3	1943	67.0	61.4
1928	62.9	70.6	1944	67.6	62.7
1929	61.9	69.9	1945	68.8	62.4
1930	56.1	60.4			
			1946	78.7	66.3
1931	47.4	38.7	1947	96.4	88.2
1932	42.1	44.5	1948	104.4	111.7
1933	42.8	40.2	1949	99.2	100.1
1934	48.7	49.5	1950	103.1	103.7
1935	52.0	50.3			
			1951	114.8	110.5
1936	52.5	56.2	1952	111.6	109.3
1937	56.1	59.3	1953	110.0	112.7
1938	51.1	54.9	1954	110.3	110.8
1939	50.1	51.3	1955	110.7	112.7
1940	51.1	49.1			
			1955: Dec.	111.3	115.6
1941	56.8	56.0	1956: Mar.	112.9	117.5

U. S. Average Prices of Gasoline in 50 Cities, by Years

Source: The Texas Co., via API. Cents per Gallon

YEAR	Service Sta. Excl. Tax	Service Sta. Incl. Tax	YEAR	Service Sta. Excl. Tax	Service Sta. Incl. Tax
1918	25.12	25.12	1938	14.07	19.51
1919	25.41	25.47	1939	13.31	18.75
1920	29.74	29.83	1940	12.75	18.41
1921	26.11	26.31	1941	13.30	19.23
1922	24.82	25.20	1942	14.46	20.43
1923	21.06	21.97	1943	14.56	20.53
1924	19.46	20.94	1944	14.62	20.59
1925	20.09	22.20	1945	14.48	20.50
1926	20.97	23.38	1946	14.69	20.77
1927	18.29	21.09	1947	16.93	23.11
1928	17.90	20.94	1948	19.54	25.88
1929	17.92	21.42	1949	20.27	26.79
1930	16.17	19.95	1950	20.08	26.76
1931	12.98	16.98	1951	20.31	27.15
1932	13.30	17.93	1952	20.24	27.56
1933	12.41	17.82	1953	21.28	28.69
1934	13.64	18.85	1954	21.56	28.95
1935	13.55	18.84	1955	21.42	29.07
1936	14.10	19.45	1955 Dec.	21.20	29.00
1937	14.59	19.99	1956 Mar.	21.32	29.12

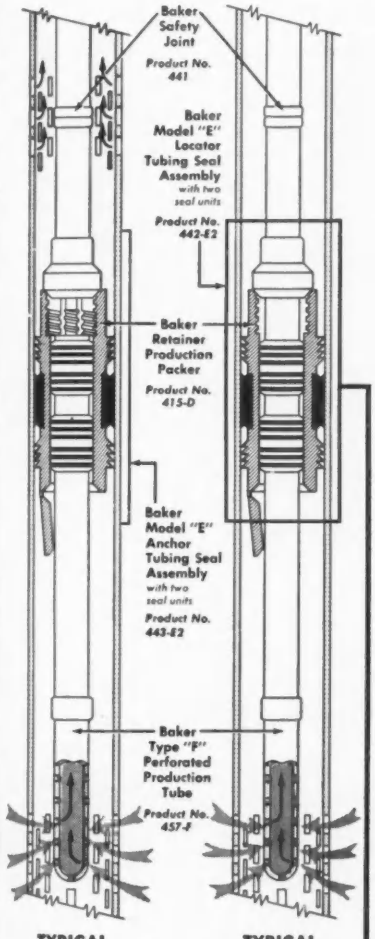
Crude Price Changes in Mid-Continent, California, and West Texas, by Years (Dollars Per Barrel)

DATE	Okla., Kans. 36-36.9° Gravity	Calif., Long Beach 27-27.9°	West Texas Sour 30-30.9°
1937: Prior to Jan. 1	$1.10	$1.10	$0.78
January 28	1.22	....	0.88
1938: October 12	1.02	....	0.75
1939: No Changes	....	....	....
1940: February 1	....	1.03	....
1941: March 29	....	....	0.82
April 1	1.07	....	....
April 24	....	1.09	....
May 20	1.17	....	....
May 21	....	....	0.92
May 23	....	1.15	....
1942: Feb. 3; frozen at Oct. 1, 1941 level	1.17	1.15	0.92
1943; 1944; 1945: No Changes; prices frozen	....	....	....
1946: April 1: OPA Raise	1.27	1.25	1.02
July 25· Oil Prices decontrolled	1.52	....	1.27
August 1	....	1.50	....
November 15	1.62	....	....
November 19	....	....	1.37
1947: March 10	1.87	....	1.62
March 19	....	1.75	....
July 1	....	1.95	....
October 15	2.07	....	....
October 16	....	....	1.82
December 6	2.57	....	2.32
December 27	....	2.45	....
1948: No Change	....	....	....
1949: June 1	....	2.37	....
1950: December 12	....	2.41	....
1951: Frozen at Jan. 25 level	2.57	2.41	2.32
1952: No Changes; Frozen	....	....	....
1953: Feb. 16; decontrolled	....	2.76	....
June 15	2.82	....	2.32
1954: No Change	....	....	....
1955: No Change	....	....	....
1956: No Change	....	....	....

SINGLE ZONE

DUAL ZONE
PRODUCTION

WITH **BAKER**


Baker Safety Joint
Product No. 441
Baker Model "E" Locator Tubing Seal Assembly with two seal units
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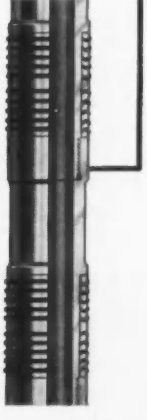
TYPICAL DUAL ZONE HOOKUP
TYPICAL SINGLE ZONE HOOKUP



Right: Picture shows actual detail of seal units

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If your well is worth completing . . . it's worth completing well

Oil Industry Earnings Up 15.4 Percent During 1955

FIFTY-THREE U. S. oil companies reported net income of $2,794,525,608 for 1955, an increase of 15.4 percent over 1954.

Of the 53 companies, only 6 reported less profit than in the previous year.

Favorable results were shown by companies of all sizes and kinds.

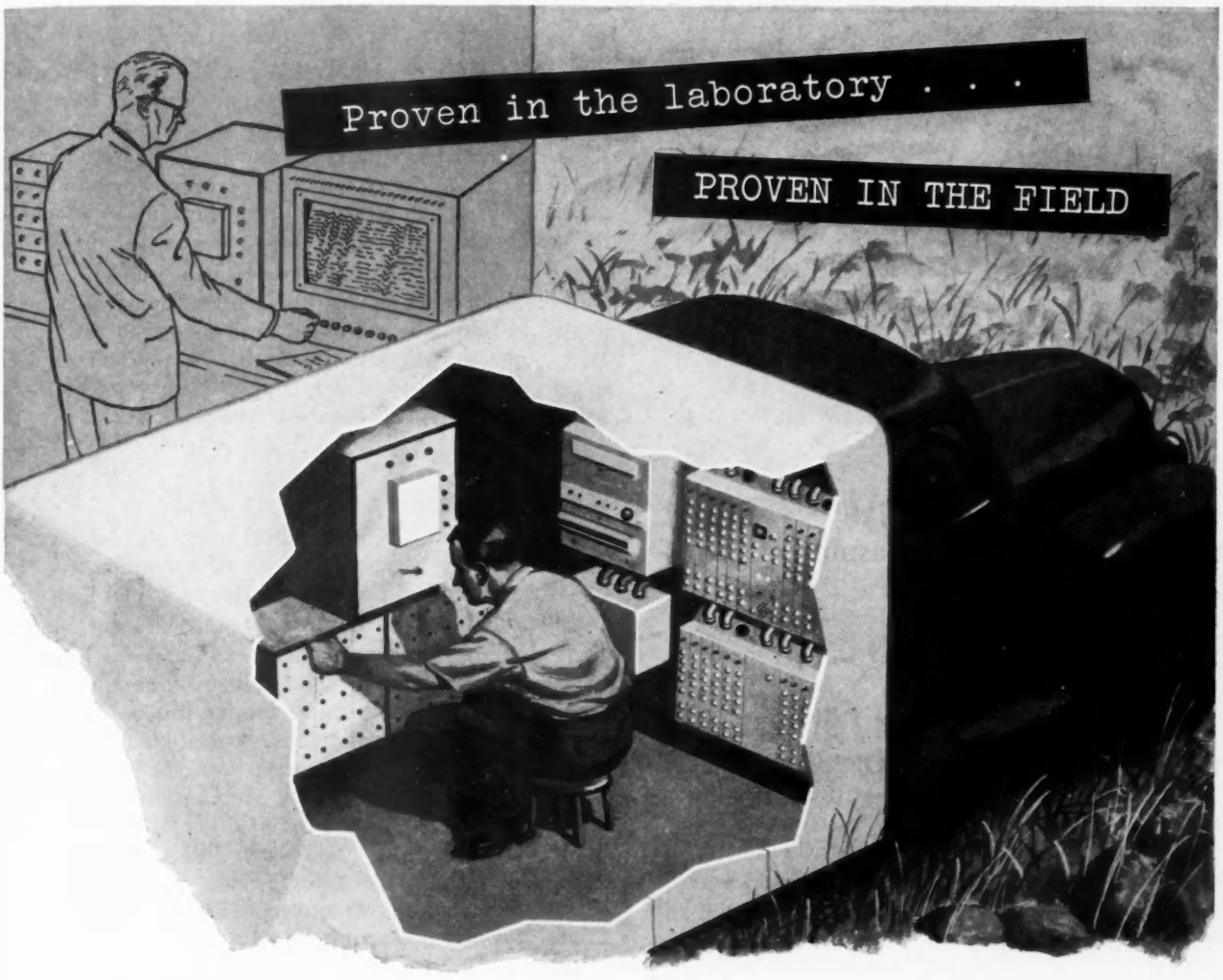
Five "international" companies, with large foreign operations, together showed an increase of 17.2 percent in earnings. Forty-eight other companies together reported an increase of 13.0 percent. However, two "internationals" had gains of only 9.1 percent and 12.9 percent, another 16.2 percent, and the other two 19.3 and 21.3 percent.

Some of the companies operating mostly in the U. S. and Canada showed better gains over 1954 than any of the "internationals." Among them were Phillips Petroleum Company, Standard Oil Company (Indiana), Standard Oil Company (Ohio), Amerada Petroleum Corporation, Crown Central Petroleum Corporation, and Quaker State Oil Refining Corporation. Others showing better than average gains included Humble Oil & Refining Company, South Penn Oil Company, Sun Oil Company, and Texas Gulf Producing Company.

Net Earnings of U. S. Oil Companies

COMPANY	TOTAL AMOUNT			PER SHARE		
	1954	1955	% Diff.	1954	1955	% Diff.
Companies with Large Foreign Operations						
Gulf Oil Corporation	$ 182,813,000	$ 218,064,000	+ 19.3	$6.87	$8.19	+ 19.2
Socony Mobil Oil Company	183,805,995	207,434,017	+ 12.9	5.25	5.93	+ 13.0
Standard Oil Company of California	211,872,447	231,138,655	+ 9.1	6.70	7.31	+ 9.1
Standard Oil Company (New Jersey)	584,793,000	709,310,000	+ 21.3	9.56	10.84	+ 13.4
The Texas Company	226,140,761	262,729,738	+ 16.2	8.24	9.57	+ 16.1
Total, 5 Companies	$1,389,425,203	$1,628,676,410	+ 17.2	....	....	....
Other Companies						
Amerada Petroleum Corporation	19,777,648	25,363,673	+ 28.2	3.13	4.02	+ 28.4
American Maracaibo Company	1,532,874	2,165,056	+ 41.2	.48	.65	+ 35.4
Anderson-Prichard Oil Corporation	54,865,334	61,291,365	+ 11.7	4.00	6.10	+ 52.5
Arkansas Fuel Oil Company	7,185,000	8,224,000	+ 14.5	1.89	2.16	+ 14.3
Argo Oil Corporation	4,288,870	4,409,299	+ 2.8	2.14	2.20	+ 2.8
Atlantic Refining Company	39,464,000	41,351,000	+ 4.8	4.25	4.47	+ 5.2
Bishop Oil Company	309,405	534,093	+ 72.6	.81	.98	+ 21.0
British American Oil Company, Ltd.	18,159,000	20,613,000	+ 13.5	2.16	2.27	+ 5.1
Cities Service Company	43,724,000	49,306,000	+ 12.8	4.41	4.88	+ 10.7
Clark Oil and Refining Company	538,240	1,436,868	+167.0	.55	1.53	+178.2
Colorado Oil and Gas Company	301,967	1,363,609	+351.6	.07	.28	+300.0
Continental Oil Company	41,683,189	46,358,772	+ 11.2	4.28	4.75	+ 11.0
Crescent Corporation	2,481,000	2,404,000	— 3.1	5.88	8.71	+ 48.1
Crown Central Petroleum Corporation	1,401,140	1,723,596	+ 23.0	1.70	2.09	+ 23.0
Delhi Taylor Oil Corporation	916,340	1,646,795	+ 79.7	.17	.31	+ 82.4
General Crude Oil Company	3,210,000	3,506,000	+ 9.2	1.70	1.86	+ 9.4
*Humble Oil and Refining Company	146,303,000	174,997,500	+ 19.6	4.08	4.88	+ 19.6
Louisiana Land and Exploration Company	12,929,467	13,438,505	+ 3.9	4.34	4.51	+ 3.9
Mississippi River Fuel Corporation	5,890,617	6,847,734	+ 16.2	1.73	2.02	+ 16.8
National Gas and Oil Corporation	496,932	622,340	+ 25.2	1.12	1.40	+ 25.0
Oceanic Oil Company	15,600	73,500	+371.2	.09	.41	+355.5
Ohio Oil Company	38,224,000	41,255,000	+ 7.9	2.91	3.14	+ 7.9
Pacific Western Oil Corporation	12,517,813	11,182,071	— 10.7	2.18	1.94	— 11.0
Panhandle Oil Corporation	959,974	902,053	— 6.0	.60	.57	— 5.0
Phillips Petroleum Company	76,129,752	95,203,057	— 25.1	5.20	5.55	+ 6.7
Plymouth Oil Company	6,759,061	6,888,159	+ 1.9	2.78	2.83	+ 1.8
Pure Oil Company	31,163,000	35,164,226	+ 12.8	3.56	4.05	+ 13.8
Quaker State Oil Refining Corporation	2,112,794	2,671,638	+ 26.5	2.56	3.24	+ 26.6
Reserve Oil and Gas Company	539,708	1,200,335	+122.4	.98	2.18	+122.4
Richfield Oil Corporation	25,570,701	29,609,448	+ 15.8	6.39	7.40	+ 15.8
Seaboard Oil Company	7,470,307	7,542,294	+ 1.0	2.04	2.06	+ 1.0
Shell Oil Company	121,127,000	125,532,000	+ 3.6	4.41	4.56	+ 3.4
Signal Oil and Gas Company	9,313,280	9,640,400	+ 3.5	2.38	2.46	+ 3.4
Sinclair Oil Corporation	74,623,256	80,709,954	+ 8.2	6.05	6.01	— 0.7
Skelly Oil Company	29,455,250	32,240,262	+ 9.5	5.12	5.61	+ 9.6
South Penn Oil Company	5,056,904	6,067,429	+ 20.0	3.14	3.64	+ 15.9
Southern Production Company	4,173,767	4,347,453	+ 4.2	2.42	2.52	+ 4.1
Standard Oil Company (Indiana)	117,156,768	157,117,828	+ 34.1	3.73	4.81	+ 29.0
Standard Oil Company (Ohio)	18,527,085	23,008,465	+ 24.2	4.41	5.53	+ 25.4
Sun Oil Company	40,343,791	48,307,360	+ 20.0	4.17	4.72	+ 13.2
Sunray Mid-Continent Oil Company	36,600,000	39,471,900	+ 7.8	2.01	2.27	+ 12.9
Texas Gulf Producing Company	5,245,527	6,320,029	+ 20.5	1.43	1.72	+ 20.3
Texas Pacific Coal and Oil Company	7,856,034	7,949,374	+ 1.2	2.19	2.22	+ 1.4
Tide Water Associated Oil Company	34,547,000	37,790,000	+ 9.4	3.13	3.03	— 3.2
Union Oil Company of California	35,887,920	30,522,963	— 15.0	4.78	4.13	— 13.6
United Gas Corporation	26,749,000	26,156,000	— 2.2	2.07	2.03	— 1.9
Universal Consolidated Oil Company	2,583,007	2,295,181	— 11.2	4.04	3.59	— 11.1
Union Oil and Gas Corporation of Louisiana	1,523,960	3,093,120	+103.0	.84	1.71	+103.6
Wilcox Oil Company	521,301	981,994	+ 88.4	1.86	3.48	+ 87.1
*Total 48 Companies	1,031,908,592	1,165,849,198	+ 13.0	....	....	.....
*Total 53 Companies	2,421,333,795	2,794,525,608	+ 15.4	....	....	.....

* Humble is excluded from totals, being included as a subsidiary of Standard Oil Company (New Jersey), which owns 87 percent of Humble stock.



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A three year design and development program produced the original concepts that led to the SIE MR-4 Magnetic Recording System. Then intensive field experimentation and SIE's unmatched manufacturing experience were combined to produce a final design of the MR-4 that meets every standard for accurate, dependable, field service.

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218-55 *The Standard of the Industry*

Frequency Range: 1 to 500 cps.

Signal-to-noise ratio: 46db peak to peak without noise cancelling circuit from 1 cps to 500 cps.
60db RMS to RMS with noise cancelling circuit from 20 cps to 100 cps.

Distortion: Less than 1%.

Specifications

Record Length: 5½ seconds

Drum Speed: 7½ in/sec.

Channels: 24 data, 4 control.

Power Source: 12 volts DC

Recorder Dimensions: 21⅜"x15⅜"x17".

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By **RAY L. DUDLEY,** Publisher, and **WARREN L. BAKER,** Editor

Higher Crude Oil Prices Are Likely

Boost in crude prices can be expected now that heavy gasoline consuming season is approaching.

HOPES FOR HIGHER CRUDE OIL PRICES in the U. S. increased sharply during the past month. In the first place, a very strong, concerted demand developed from independent producers for higher prices. There was widespread acceptance of the need for higher prices to offset increased costs, but apparently there was some reluctance by purchasers to take such action as long as there was a possibility that gasoline supplies might become excessive.

Furthermore, inventory trends in recent weeks offered some encouragement for higher prices. Gasoline stocks started their seasonal decline without becoming too excessive, although they approached this point. This is the only product with any leaning toward the surplus side. It was particularly significant that most of the decrease in gasoline stocks was occurring in the large and important marketing territory lying east of California. Inventories in this area dropped to levels that were a little nearer to volumes of the preceding year than they had been in earlier months.

However, crude runs to refinery stills during the next month or two continued to hold the key to the situation. If refining operations remain near recent restricted levels, the gasoline situation will improve. This would greatly enhance the outlook. Higher crude oil prices would then be almost assured. On the other hand, if refinery runs are too large during coming weeks, the resulting surplus gasoline supply might weaken the market for this product to such an extent that higher crude prices would be unlikely.

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IN REQUESTING HIGHER PRICES, U. S. producers were declaring that increasing costs made a price boost necessary. The last widespread crude prices change occurred in June, 1953. Since that time oil wages have risen by more than 9 percent; oil field tubular goods have increased more than 10 percent and the composite price of finished steel is up more than 11 percent. These increases are said to indicate an over-all increase of 20 percent in oil finding and replacement costs.

Producers were pointing out that this situation must be corrected if the U. S. is to develop sufficient producing ability to fulfill the increased need for oil in the future. With huge growth anticipated in the nation's oil consumption rate, any slackening of efforts to find new sources of supply were seen as a serious matter.

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GASOLINE STOCKS started their seasonal decline early in April. After reaching a peak of 198 million barrels on March 30, U. S. inventories of motor fuel had fallen to 195 million barrels by April 13.

At the latter level national stocks were still 13 million barrels larger than year ago volumes, although they had been only 12 million above 1955 quantities in mid-March. However, some improvement occurred in the territory east of California. Inventories east of California accounted for practically all the decrease, and on April 13 were only 9½ million barrels larger than 12 months before although they had been 10¾ million barrels larger just two weeks before. Since the region east of California is the largest and most important market territory, this improvement held real significance.

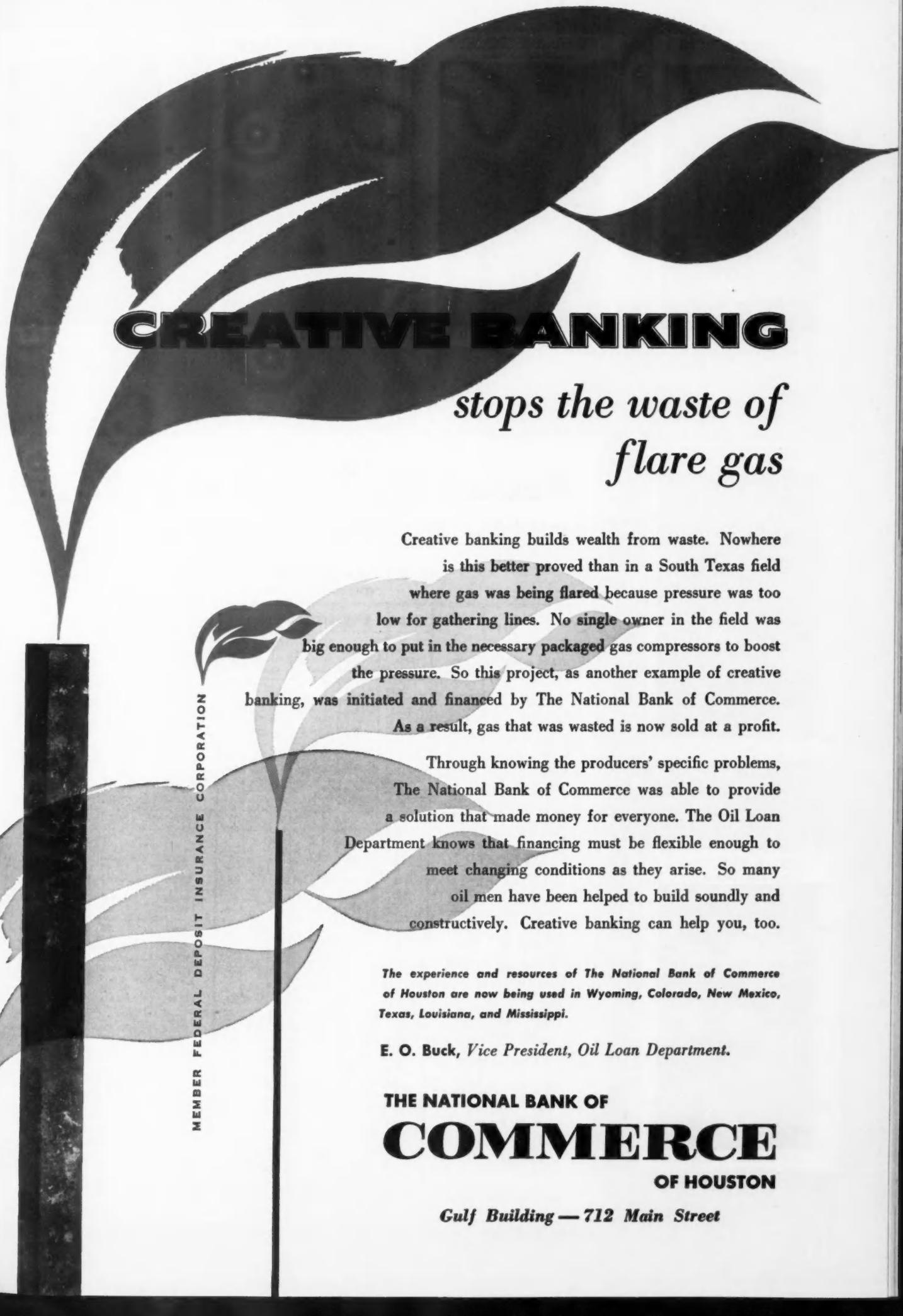
Drafts on gasoline stocks during the last two weeks occurred with crude runs to refining stills averaging a little over 7½ million barrels daily in contrast with 8 million barrels per day during the first three months of the year. If runs continue to be held near this volume during the remainder of April and all of May, gasoline stocks will be reduced by substantial amounts. This would put the whole oil picture in a strong position.

•

OTHER OIL STOCKS are in excellent condition. Distillate fuel stocks on April 13 were 2½ million barrels less than a year before. At the end of February they had been 4 million barrels larger than at the corresponding time in 1955.

Crude oil stocks at the beginning of April totaled 262 million barrels. Although this was 4½ million barrels less than a year ago, it was 4 million more than in tanks at the start of February. The situation will be helped by a lower crude oil production allowable in Texas during May.

All in all, the economic position of the industry is in good condition. Reasonable refining levels during the next month or two could result in further improvement, while excessive crude runs to stills would be dangerous and damaging.


CREATIVE BANKING
stops the waste of
flare gas
Creative banking builds wealth from waste. Nowhere is this better proved than in a South Texas field where gas was being flared because pressure was too low for gathering lines. No single owner in the field was big enough to put in the necessary packaged gas compressors to boost the pressure. So this project, as another example of creative banking, was initiated and financed by The National Bank of Commerce. As a result, gas that was wasted is now sold at a profit.
Through knowing the producers' specific problems, The National Bank of Commerce was able to provide a solution that made money for everyone. The Oil Loan Department knows that financing must be flexible enough to meet changing conditions as they arise. So many oil men have been helped to build soundly and constructively. Creative banking can help you, too.
The experience and resources of The National Bank of Commerce of Houston are now being used in Wyoming, Colorado, New Mexico, Texas, Louisiana, and Mississippi.
E. O. Buck, Vice President, Oil Loan Department.
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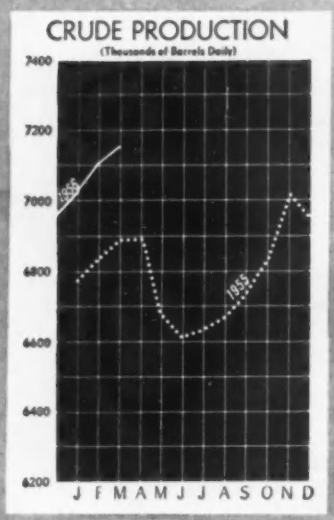
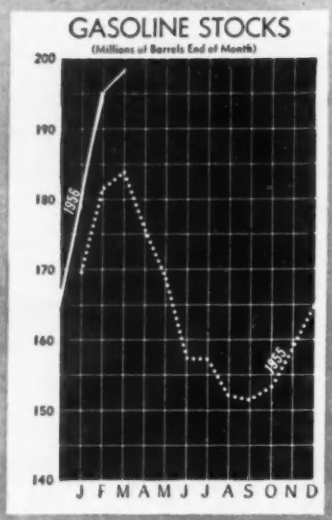
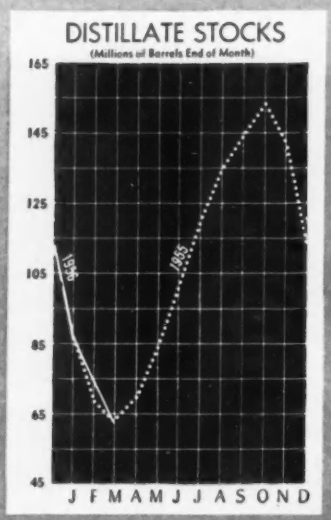
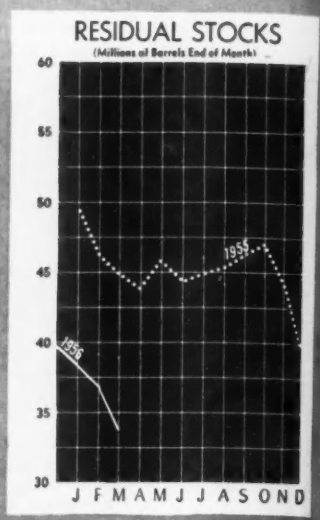
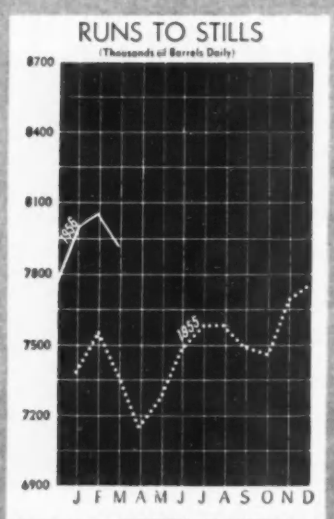
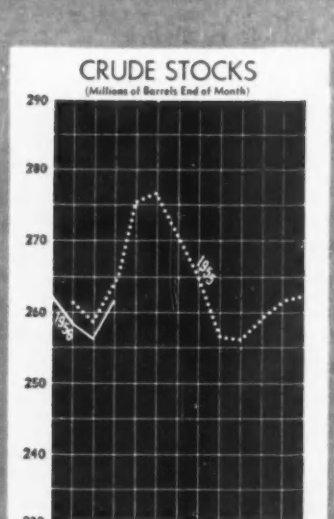












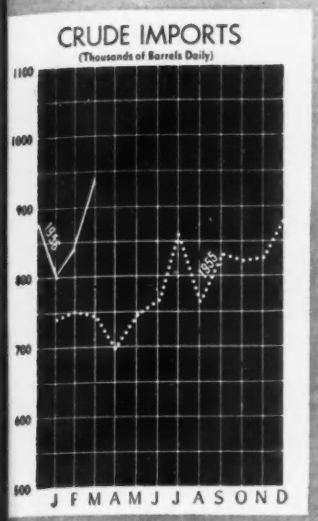
Petroleum Trends In U. S. . . .

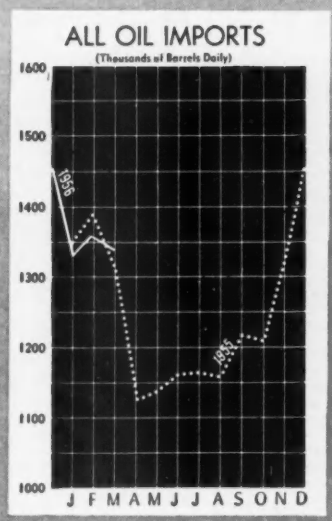
By CECIL W. SMITH, World Oil Staff

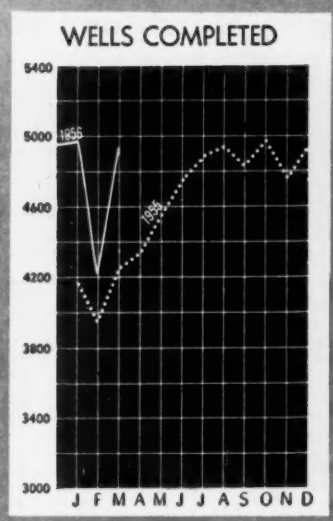
U. S. Crude Production by States

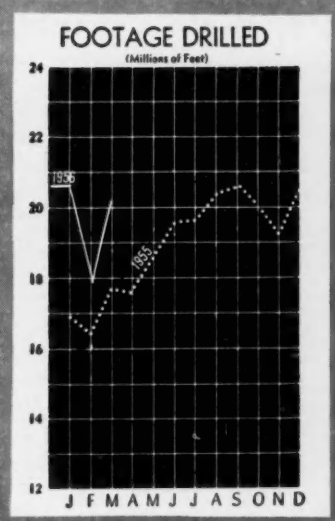
(THOUSANDS OF BARRELS)

STATE or DISTRICT	DAILY AVERAGE PRODUCTION Mar. 1956	Feb. 1956	Mar. 1955	% Diff. Mar. '56-'55	TOTAL PRODUCTION First Three Months 1956	1955	% Diff. '56-'55
Alabama	4.5	4.3	3.6	+25.0	395	357	+ 10.6
Arkansas	74.0	73.6	78.6	— 5.9	6,701	6,974	— 3.9
California	966.1	972.6	971.5	— 0.6	88,504	87,088	+ 1.6
Colorado	160.7	159.4	122.4	+31.3	14,520	10,946	+ 3.72
Florida	1.4	1.4	1.3	+ 7.7	125	116	+ 7.8
Illinois	232.8	228.8	216.8	+ 7.4	21,044	19,135	+ 10.0
Indiana	31.8	31.4	28.7	+10.8	2,854	2,604	+ 9.6
Kansas	343.3	332.5	344.2	— 0.3	30,728	30,798	— 0.2
Kentucky	46.9	45.4	39.3	+19.3	4,158	3,483	+ 19.4
Louisiana	817.5	802.6	723.3	+13.0	73,087	64,093	+ 14.0
North Louisiana	121.2	119.9	120.0	+ 1.0	10,884	10,647	+ 2.2
South Louisiana	696.3	682.7	603.3	+15.4	62,203	53,446	+ 16.4
Michigan	29.8	30.2	32.3	— 7.7	2,737	2,893	— 5.4
Mississippi	110.8	111.4	96.5	+14.8	10,121	8,510	+ 18.9
Missouri	0.2	0.2	0.2	.....	14	17	— 17.7
Montana	52.4	50.5	44.6	+17.5	4,622	3,971	+ 16.4
Nebraska	30.0	29.2	23.6	+27.1	2,668	2,054	+ 29.9
Nevada	0.2	0.3	0.2	.....	23	16	+ 43.8
New Mexico	242.1	235.8	221.5	+ 9.3	21,470	19,892	+ 7.9
Southeast New Mexico	240.4	234.1	218.6	+ 7.1	21,322	19,637	+ 8.6
Northwest New Mexico	1.7	1.7	2.9	—41.4	148	255	— 42.0
New York	9.7	10.2	8.2	+18.3	907	725	+ 25.1
North Dakota	36.3	34.4	28.8	+26.0	3,405	2,737	+ 24.4
Ohio	12.6	12.5	11.7	+ 7.7	1,149	979	+ 17.4
Oklahoma	618.5	608.5	561.7	+10.1	55,408	49,360	+ 12.3
Pennsylvania	18.4	19.3	23.3	—21.0	1,731	1,989	— 13.0
South Dakota	0.1	0.1	0.1	.....	5	9	— 44.5
Tennessee	0.1	0.1	0.1	.....	3	5	— 40.0
Texas	3,026.1	3,026.4	3,022.3	+ 0.1	272,829	270,578	+ 0.8
Dist. 1—South Central	54.4	53.2	51.5	+ 5.6	4,744	4,430	+ 7.1
Dist. 2—Middle Gulf	159.6	159.8	159.2	+ 0.2	14,586	14,223	+ 2.6
Dist. 3—Upper Gulf	455.4	465.8	478.0	— 4.7	41,725	42,680	— 2.2
Dist. 4—Lower Gulf-S.W.	252.3	251.4	263.1	— 4.1	22,792	23,380	— 2.5
Dist. 5—East Central	47.4	47.0	49.4	— 4.1	4,275	4,471	— 4.4
Dist. 6—Northeast	356.1	359.1	369.8	— 3.7	32,512	11,725	+ 77.3
Dist. 7-B—North Central	162.6	156.0	142.9	+13.8	14,229	21,439	— 33.6
Dist. 7-C—West Central	181.8	182.8	194.7	— 6.6	16,331	12,725	+ 28.3
Dist. 8—West	1,051.7	1,049.4	978.0	+ 7.5	94,464	16,995	+ 55.8
Dist. 9—North	210.7	208.7	195.7	+ 7.7	18,694	87,287	— 78.6
Dist. 10—Panhandle	94.1	93.2	87.5	+ 7.5	8,477	17,375	— 51.2
Utah	5.2	6.6	5.2	.....	540	485	+ 11.3
Virginia	0.1	0.1	0.1	.....	9	3	+300.0
West Virginia	6.1	6.3	6.9	—11.6	557	591	— 5.8
Wyoming	279.3	283.2	268.6	+ 4.0	25,808	24,038	+ 7.4
Total United States	7,157.0	7,117.3	6,855.6	+ 3.9	646,122	614,446	+ 5.2







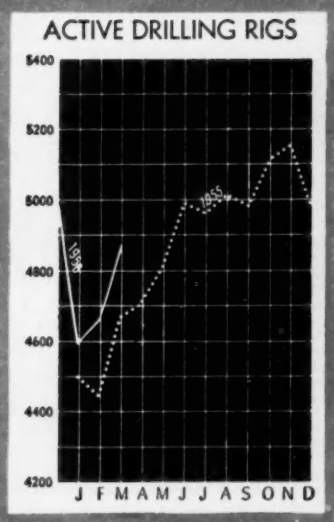


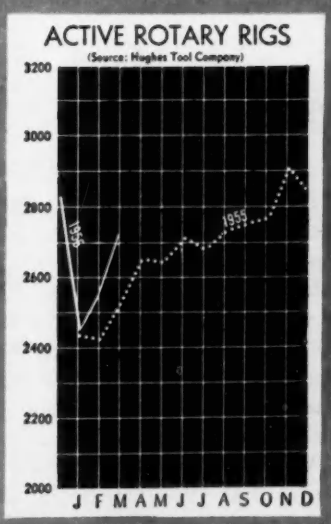
- **Crude production continues gain**
- **Drilling rates pushed upwards**
- **Crude imports at highest level**

Crude Oil and Refined Products Trends
(THOUSANDS OF BARRELS)

MONTH	CRUDE OIL			GASOLINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1954:											
February..	6,379	7,068	266,918	3,476	179,950	1,545	70,390	1,241	47,119	621	1,144
March....	6,507	6,923	271,867	3,375	181,297	1,458	60,270	1,168	44,249	654	1,088
April.....	6,615	6,811	280,310	3,404	177,006	1,374	61,721	1,140	44,362	574	950
May.....	6,471	7,038	282,250	3,482	177,606	1,372	73,581	1,148	47,009	708	1,021
June.....	6,500	6,947	285,155	3,483	165,404	1,399	86,325	1,123	50,216	624	999
July.....	6,242	6,916	284,894	3,480	158,010	1,416	101,657	1,089	54,365	724	1,038
August....	6,168	6,862	281,043	3,492	153,168	1,453	117,579	1,069	56,322	664	966
September.	6,151	6,939	274,608	3,511	150,916	1,514	128,061	1,086	56,702	672	999
October...	6,135	6,834	269,442	3,457	149,661	1,545	139,128	1,066	56,541	642	1,065
November.	6,346	6,975	264,566	3,530	150,604	1,622	133,886	1,120	54,891	636	1,104
December.	6,394	7,238	258,385	3,605	155,400	1,668	108,144	1,187	52,105	729	1,301
1955:											
January...	6,761	7,379	260,156	3,639	169,562	1,740	86,692	1,235	49,457	739	1,348
February..	6,835	7,549	258,630	3,655	181,643	1,847	68,513	1,239	46,042	751	1,379
March....	6,886	7,374	264,430	3,543	183,972	1,703	62,457	1,185	44,970	742	1,319
April.....	6,887	7,136	275,232	3,502	175,601	1,534	70,139	1,110	43,838	697	1,123
May.....	6,677	7,281	276,948	3,605	168,751	1,519	83,559	1,111	45,083	742	1,137
June.....	6,613	7,484	270,850	3,725	157,439	1,628	100,652	1,080	44,398	764	1,159
July.....	6,632	7,580	264,601	3,824	157,079	1,575	119,169	1,091	44,894	860	1,161
August....	6,665	7,580	256,427	3,858	151,912	1,621	133,675	1,090	45,480	756	1,155
September.	6,731	7,483	256,269	3,784	150,194	1,621	143,248	1,061	46,267	829	1,218
October...	6,831	7,465	267,346	3,827	153,103	1,612	152,288	1,123	47,040	821	1,206
November	7,014	7,692	260,707	3,867	157,871	1,680	141,808	1,214	44,071	823	1,322
December	7,155	7,762	265,610	3,916	165,433	1,765	111,333	1,286	39,174	884	1,502
1956:											
January...	7,199	8,023	261,592	3,927	183,905	1,923	86,141	1,344	38,247	805	1,422
February.	7,117	8,045	256,964	3,726	194,474	1,939	72,414	1,285	36,388	842	1,364
March...	7,157	7,907	262,066	3,711	198,082	1,818	62,330	1,221	33,718	948	1,342
Mar. 1956 Change:											
In Month	+40	−138	+5,102	−15	+3,608	−121	−10,084	−64	−2,670	+106	+22
In Year..	+271	+533	−2,364	+168	+14,110	+115	−127	+36	−11,252	+206	+23
Week Ended:											
4-13-56 ..	7,156	7,551	267,085	3,631	195,059	1,739	60,832	1,168	32,788	820	1,271
4-15-55...	6,828	7,131	271,425	3,431	181,864	1,549	63,360	1,147	44,741	836	1,227

Source: Data for last two months from API; prior monthly data from Bureau of Mines.





U. S. Wells Completed in March and First Three Months, 1956-1955

STATE or DISTRICT	NEW WELLS COMPLETED AND FOOTAGE DRILLED: DETAILS FOR MARCH: Oil	Dist.	Gas	Dry	Water Input	Gas Input	Water Disposal	TOTAL NEW WELLS: Mar., 1956	Feb., 1956	Mar., 1955	Total Footage March, 1956	DETAILS FOR JANUARY-MARCH: NEW WELLS: 1956	1955	Percent Diff.	FOOTAGE: 1956	1955	Rigs in Operation: Mar. 31, 1956	Feb. 29, 1956	Mar. 31, 1955
Alabama	2		1	2				5	5	6	41,063	17	20	— 15.0	138,415	78,369	15	10	7
Arizona													4	—100.0		16,136			
Arkansas	58			20				78	48	52	243,800	195	135	+ 44.4	616,683	466,864	52	57	47
California	134		4	80				218	171	209	1,000,897	591	548	+ 7.8	2,800,707	2,660,153	223	211	282
Colorado	25		9	72				106	101	106	577,970	340	322	+ 5.6	1,825,820	1,737,586	69	59	88
Florida				1				1	4	3	6,832	6	12	— 50.0	35,002	74,689			3
Georgia																	2	2	
Idaho				1				1			4,528	1	1		4,528	4,530	1		1
Illinois	105		6	126				237	191	234	541,882	745	777	— 4.1	1,753,015	1,878,812	240	187	242
Indiana	14		1	29	1			45	29	47	77,077	138	127	+ 8.7	235,350	199,288	75	69	81
Kansas	188		35	158			5	386	354	381	1,407,025	1,090	1,046	+ 4.2	3,969,191	3,832,383	449	435	489
Kentucky	53		18	64	1			136	106	94	193,975	412	326	+ 26.4	581,907	544,740	126	132	96
Louisiana	169	11	23	111				314	279	318	2,345,799	838	962	— 12.9	6,596,079	5,849,055	430	396	358
North Louisiana	72		8	36				116	91	162	437,100	278	518	— 46.3	1,060,760	1,435,882	86	72	76
South Louisiana	97	11	15	75				198	188	156	1,908,699	560	444	+ 26.1	5,535,319	4,413,173	344	324	282
* Gulf of Mexico	26		1	15				42	39	21	409,132	113	67	+ 68.7	1,037,342	630,471	75	67	42
Maryland																	2	2	4
Michigan	19		2	20				41	37	33	108,872	132	130	+ 1.5	368,506	387,328	62	71	76
Mississippi	6		1	25				32	34	44	239,012	105	121	— 13.2	774,458	920,227	32	36	46
Missouri	1		1	11				13		5	10,635	14	13	+ 7.7	12,595	7,835		2	1
Montana	18		1	10				29	25	12	168,972	105	72	+ 45.8	539,247	372,380	38	38	35
Nebraska	26			54				80	75	51	465,052	241	147	+ 63.9	1,350,490	833,875	48	40	34
Nevada									1	1		1	4	— 75.0	7,885	29,916	4	3	2
New Mexico	77		40	25				142	151	139	642,708	439	332	+ 32.2	2,084,331	1,464,675	188	154	154
New York	20				12			32	23	27	44,700	81	78	+ 3.8	116,600	107,920	50	40	45
North Dakota	14			7				21	27	22	172,949	69	51	+ 35.3	543,278	373,220	22	21	24
Ohio	45		11	17				73	81	84	184,943	252	243	+ 3.7	616,051	525,422	218	212	204
Oklahoma	448	12	37	203	10		18	728	831	666	2,585,606	2,100	1,637	+ 28.3	7,592,749	5,668,701	656	640	660
Oregon																			1
Pennsylvania	25		41	17	22	1		106	91	55	267,535	294	171	+ 71.9	761,996	316,015	143	134	106
South Dakota									1			1	2	— 50.0	9,361	6,752	1	1	2
Texas	1,245	18	61	664	10		5	2,003	1,719	1,583	8,285,081	5,611	4,739	+ 18.4	23,564,567	20,806,674	1,473	1,467	1,346
Dist. 1: South Central	127		1	58				186	146	166	472,695	505	432	+ 16.9	1,327,302	1,166,835	77	48	54
Dist. 2: Middle Gulf	25	4	5	40				74	58	65	448,916	221	195	+ 13.3	1,368,019	1,200,708	51	50	29
Dist. 3: Upper Gulf	86	3	12	66				167	140	170	1,089,455	445	446	— 0.2	2,932,228	2,883,774	165	151	129
* Gulf of Mexico			1					1	3	1	8,013	4	1	+400.0	40,088	13,386	1	4	4
Dist. 4: Lower Gulf-S.W.	50	10	13	41			1	115	119	117	564,266	341	344	— 0.9	1,803,001	1,830,612	73	82	67
* Gulf of Mexico										3			6	—100.0		54,743	2	2	
Dist. 5: East Central	5		1	19				25	9	30	85,180	67	81	— 17.3	225,714	344,524	7	16	17
Dist. 6: Northeast	32		5	23				60	64	51	332,948	210	151	+ 39.1	1,114,603	842,108	67	67	55
Dist. 7-B: North Central	132		1	137	2		1	273	211	265	962,100	840	782	+ 7.4	2,838,392	2,330,857	171	155	157
Dist. 7-C: West Central	93	1	2	30	1			127	106	116	574,800	323	323		1,522,325	1,762,932	124	135	139
Dist. 8: West	330		3	54	3			390	321	339	1,943,928	1,003	887	+ 13.1	5,069,437	4,863,130	362	413	386
Dist. 9: North	290		4	183	4		3	484	462	176	1,438,986	1,345	842	+ 59.7	4,213,819	2,701,738	269	255	242
Dist. 10: Panhandle	75		14	13				102	83	88	371,717	311	256	+ 21.5	1,149,727	879,456	107	95	71
Utah			1	7				8	7	3	24,806	37	23	+ 60.9	171,495	129,790	21	19	13
West Virginia	6		50	11				67	49	48	188,288	194	152	+ 27.6	522,552	409,891	175	175	175
Wyoming	46			25				71	60	44	316,685	241	179	+ 34.6	1,179,447	928,027	68	64	70
Total United States	2,744	41	343	1,760	56	1	28	4,973	4,218	4,267	20,146,692	14,290	12,374	+ 15.5	58,772,305	50,631,253	4,883	4,677	4,683
Total Western Canada	164		8	80				252	196	197	1,257,148	707	639	+ 10.6	3,395,130	2,819,635	173	233	186

* Gulf of Mexico wells are included in their respective district totals.

Drilling Bounces Back

March operations stage usual comeback to top 1955 record by 15.5 percent.

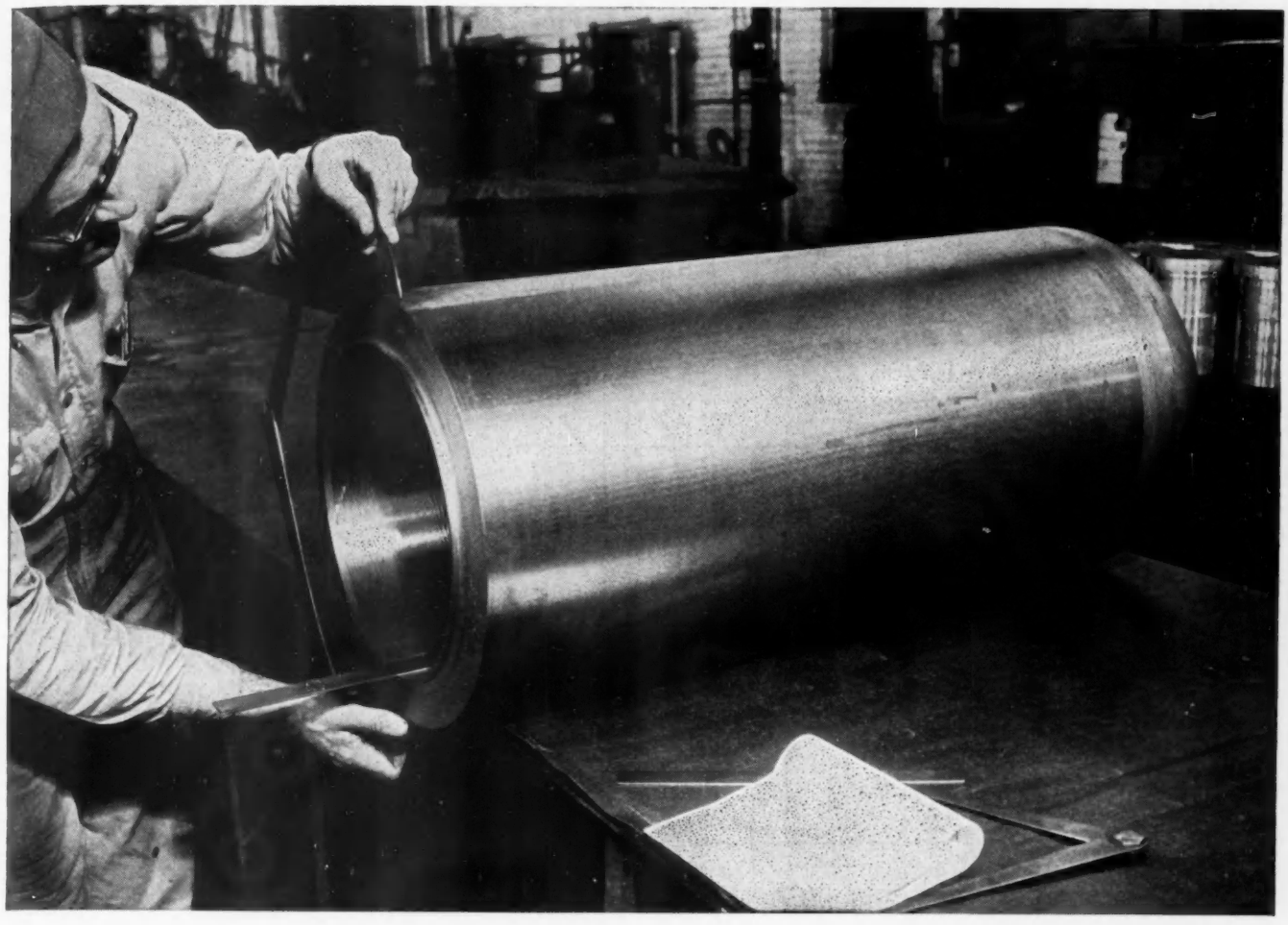
DRILLING OPERATIONS bounced back during March after a month that is traditionally slack. Drillers catch their breaths during February as weather makes it the slowest period of the year, but they came back this year, as usual, with a rush and seem intent on making 1956 the greatest drilling year in history.

When records were all in, in was found that 4973 new wells had been completed, against February's 4218. That was substantially more wells than were completed in March of last year, and although the campaign is just getting under way, it begins to appear that first-of-the-year estimates of 1956 drilling were a bit conservative.

The initial quarter saw a total of 14,290 new wells completed for an increase of 15.5 percent over the 12,374 credited to the same period of last year. In 1955, the first quarter's wells amounted to 22 percent of the final total for the year, and if the same were to be true this year, the industry would wind up with about 64,000 new wells. However, the year's total is not expected to reach such heights, but it is becoming more apparent that the year's end could see closer to 60,000 new wells than the almost 58,000 forecast at the beginning. Such a possibility would certainly gain strength if crude prices were hiked, as is being talked in certain quarters.

This year's wells are being drilled to a little deeper depth on the average than were 1955's, and consequently the amount of footage drilled so far has enjoyed a little better increase than has the number of wells. In three months, a total of 58,772,305 feet was drilled, and that was a gain of 16.1 percent over the 50,631,253 feet drilled in last year's wells.

Western Canada is also experiencing a healthy increase in drilling operations. So far, new wells total 707 to top last year's by 10.6 percent.



The Bethlehem shops produce major parts for rotary rock bits. This spindle forging is a good example.

Oil-Country Forgings

Whenever you need forgings, it's economically sound to make Bethlehem your chief source of supply. Our prices and deliveries are fully competitive, and nobody beats us on quality.

The photograph above shows one of the many types of oil-country forgings we supply regularly. It is a shell used in equipment that separates water and hydrocarbons from natural gas. Made by Bethlehem's pierce-forging process, this particular piece is 4 ft long, has an ID of 12 in., and weighs in the neighborhood of 900 lb.

Cylindrical forgings of this type can be handled by Bethlehem in weights from 25 to 5,000 lb, with ODs ranging from 4 to 28 in. and IDs from 1⅞ to 16½ in. Lengths of almost 6 ft can be produced by our draw-bench equipment.

We'd like to mention, too, that we're equipped to furnish kelly and drill-collar blanks, drop forgings of any design, gear and sheave-wheel blanks, and other types of forgings. Call or write us for information.

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Wildcat Drilling—in March and First Three Months, 1956-1955

STATE or DISTRICT	MONTH OF MARCH, 1956						FIRST THREE MONTHS, 1956-1955									
	New Fields			Total Discoveries	Dry Wildcats	Total Wildcat Tests	New Fields			Total Discoveries		Dry Wildcats		Total Wildcat Tests	
	Oil	Distillate	Gas				Oil	Distillate	Gas	3 Mo. 1956	3 Mo. 1955	3 Mo. 1956	3 Mo. 1955	3 Mo. 1956	3 Mo. 1955
Alabama	..	..	1	1	2	3	...	..	1	1	...	5	20	6	20
Arizona	..	..	..	...	...	....	...	..	..	...	...	....	4	....	4
Arkansas	..	..	..	...	6	6	1	..	2	3	3	28	30	31	33
California	..	..	..	...	40	40	..	..	1	1	5	49	66	50	71
Colorado	3	..	..	3	52	55	7	..	2	9	18	150	167	159	185
Florida	..	..	..	...	1	1	...	..	..	...	...	6	11	6	11
Idaho	..	..	..	...	1	1	...	..	..	...	...	1	1	1	1
Illinois	..	..	..	...	64	64	2	..	..	2	3	174	140	176	143
Indiana	..	..	..	...	17	17	1	..	..	1	6	38	30	39	36
Kansas	24	..	1	25	81	106	48	..	5	53	47	218	187	271	234
Kentucky	..	..	..	...	11	11	...	..	..	...	4	32	18	32	22
Louisiana	2	5	1	8	44	52	5	9	3	17	10	114	98	131	108
North Louisiana	..	..	..	...	14	14	...	..	..	...	1	34	41	34	42
South Louisiana	2	5	1	8	30	38	5	9	3	17	9	80	57	97	66
Michigan	..	..	..	...	14	14	2	..	..	2	1	41	50	43	51
Mississippi	..	..	..	...	14	14	...	1	..	1	2	43	45	44	47
Missouri	..	..	..	...	8	8	...	..	..	...	...	9	8	9	8
Montana	1	..	..	1	8	9	4	..	1	5	1	31	23	36	24
Nebraska	5	..	..	5	39	44	11	..	..	11	8	110	61	121	69
Nevada	..	..	..	...	...	....	...	..	..	...	...	....	3	....	3
New Mexico	3	..	..	3	14	17	7	..	1	8	10	41	30	49	40
North Dakota	1	..	..	1	5	6	4	..	..	4	...	16	9	20	9
Ohio	..	..	..	...	1	1	...	..	..	...	1	1	6	1	7
Oklahoma	16	5	2	23	57	80	29	7	6	42	33	179	123	221	156
South Dakota	..	..	..	...	...	....	...	..	..	...	...	1	2	1	2
Texas	40	3	7	50	388	438	128	11	22	161	173	1,164	1,032	1,325	1,205
Dist. 1: South Central	3	..	..	3	41	44	8	..	3	11	6	135	102	146	108
Dist. 2: Middle Gulf	..	..	..	...	24	24	3	1	1	5	11	54	56	59	67
Dist. 3: Upper Gulf	..	1	1	2	39	41	6	6	3	15	13	111	103	126	116
Dist. 4: Lower Gulf-S.W.	..	2	1	3	24	27	2	2	4	8	15	94	101	102	116
Dist. 5: East Central	..	..	..	...	11	11	...	..	..	...	5	34	37	34	42
Dist. 5: Northeast	2	..	..	2	17	19	4	1	1	6	1	57	43	63	44
Dist. 7-B North Central	22	..	2	24	91	115	44	..	3	47	46	265	232	312	278
Dist. 7-C West Central	3	..	..	3	23	26	13	..	1	14	12	59	67	73	79
Dist. 8: West	4	..	..	4	36	40	25	..	..	25	20	106	113	131	133
Dist. 9: North	6	..	2	8	75	83	19	..	3	22	41	229	171	251	212
Dist. 10: Panhandle	..	..	1	1	7	8	4	1	3	8	3	20	7	28	10
Utah	..	..	1	1	7	8	1	..	2	3	3	28	16	31	19
West Virginia	..	..	..	...	...	....	...	..	..	...	2	....	7	....	9
Wyoming	..	1	..	1	12	13	1	1	1	3	8	71	39	74	47
Total United States	95	14	13	122	886	1,008	251	29	47	327	338	2,550	2,226	2,877	2,564

Wildcats Regain Lost Ground

March activity pushes this year's tests to 12.2 percent lead over 1955.

WILDCAT DRILLING was back in full swing during March and the results were more than 1000 tests completed and about the average number of discoveries made. This climb-back came after February's customary slackening that comes from the unfavorable weather conditions of many parts of the country.

A total of 1008 wildcat wells were completed during the month to further advance this year's lead over record-breaking 1955. The month's efforts resulted in 122 new discoveries being made, which amounted to 12.1 percent of total tests drilled, and which boosted the year's discoveries almost up to last year's record. However, this year's search has been trailing almost 10 percent in the discovery column.

March's wildcats advanced the year's total to 2877, which was 12.2 percent more than the 2564 completed in the first quarter of last year. Yet, this increase in wildcatting activity has not paid off in comparison with the 1955 experience. The 327 new discoveries made in 1956's first three months failed by 3.3 percent of matching the 338 made in last year's comparable period by fewer tests.

So far, successful wildcats have amounted to 11.4 percent of the total drilled, while last year's success rate had figured 13.2 percent.

The month's discoveries included 95 new oil fields, and they jumped the total found in the initial quarter to 251. That total was only two short of matching the 253 oil fields located in the same period of 1955.

Also included in March's finds were 14 new gas-distillate fields, which raised the year's number to 29 and three less than the 32 scored by the same date in 1955. Thirteen new gas fields brought the year's gas discoveries to 47, but they still trailed the 53 opened a year ago.

While the industry is stepping up its exploration activities little encouragement can come from the fact that in the first three months all of the extra tests drilled ended up as dry holes.

Summary of Results of Wildcat Drilling

ITEM	Mar., 1956	Feb., 1956	THREE MONTHS January-March 1956	1955	Percent Dif.
New Field Discoveries:					
Oil	95	83	251	253	— 0.8
Distillate	14	7	29	32	— 9.4
Gas	13	13	47	53	— 11.3
Total Discoveries	122	103	327	338	— 3.3
Dry Wildcats	886	707	2,550	2,226	+ 14.6
Total Wildcats	1,008	810	2,877	2,564	+ 12.2
Percent Productive	12.1	12.7	11.4	13.2	.....
Percent Dry	87.9	87.3	88.6	86.8	.....

FIGURE 1—Typical installation of the Micro-RESEARCH-Card Library showing the file cabinet containing the entire library, the sorting box and needles, a map indexed with areawise subdivisions, and an operator viewing an article with the microfilm reader.

Features of the file include:

- **8000 complete articles in two file drawers.**
- **Manual, needle sorting system.**
- **Sorting by geologic subject, by area, by geologic time, by author.**
- **Positive full size reproduction on green glass.**

How Microfilm Library Aids Research

This company wanted a complete and usable library on Rocky Mountain geology. What they came up with may be only the beginning.

By JOHN CHRONIC, Department of Geology, University of Colorado, Boulder, Colorado

BECAUSE OF THE vast volume of literature which is being printed at an ever-increasing rate, geologists, like other scientists, gradually have been losing ground in their efforts to keep informed on latest developments in their realm of specialized knowledge. Furthermore, large quantities of data of great interest to them are filed away in theses and unpublished reports, difficult of access, uncatalogued, untouched by bibliographers.

In order to help alleviate this situation for its scientific staff, Petroleum Research Corporation has developed and is producing the Micro-RESEARCH-Card Library of the Rocky Mountain region. This library contains microphotographic reproductions of approximately 8000 published and unpublished articles and theses—not just the references, but the articles themselves—yet the entire library fits easily into a two-drawer, legal-size file cabinet. Included are papers from more than 80 periodicals (including WORLD OIL), publications and unpublished reports of the U. S. Geological Survey, and an almost untapped wealth of theses.

Furthermore, the material in this file is so arranged that it can be sorted, in a matter of a minute or so, by geologic subject, by area, or by geologic time. Any article can also be selected by author.

Hard to believe? No. The file contains approximately 8000 5-by-8-inch film transparencies, each imprinted with up to 100 pages of text reproduced about 1/20 the size of the original. The card is perforated at one

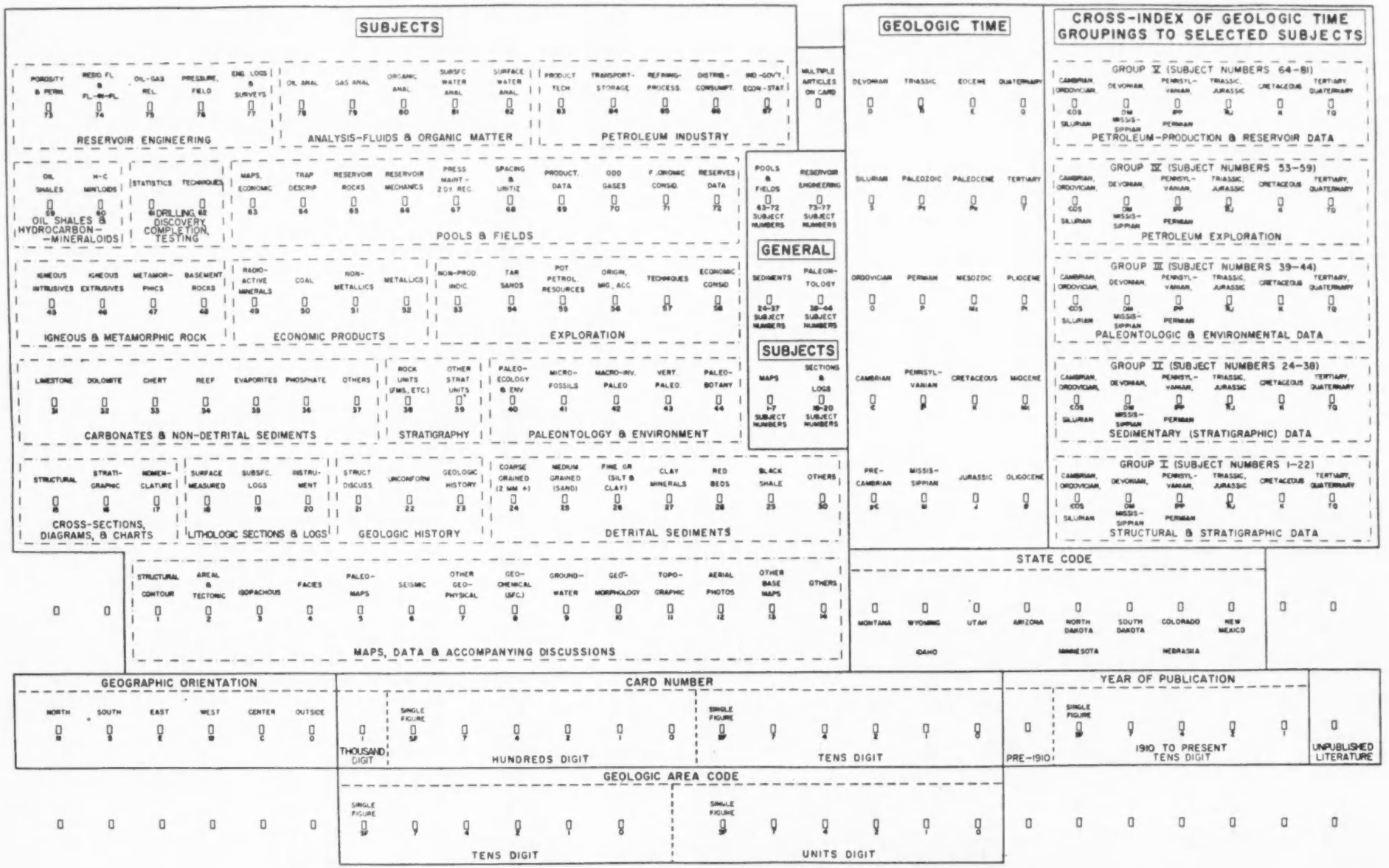


FIGURE 2—Sorting guide of the Rocky Mountain edition identifying the sorting holes for each category of the library.

end with 207 small holes. Each hole represents a geologic subject, a geologic time, date of writing, or geographic area within the Rocky Mountains.

Every article included in the file has been "coded" by a geologist to indicate area, subject, and geologic time covered by the article. The geologist's notations appear on the card in microfilm form and also as slots extended from the holes in the punched end of the card. These slots make possible the selection of material by subjects. A needle-sorting system is used, one that needs no machine for its operation. Cards are sorted by hand in a small plastic sorting box, using needles best described as knitting needles with handles. When a needle is inserted through the hole representing the subject desired, and the sorting box inverted, cards containing information on the subject drop down about a quarter of an inch and can be separated readily from the others.

Cards are read on an enlarging reader that differs from a standard microfilm reader only in the absence of microfilm spools and in the ability to hold large cards. Photographed pages are enlarged on a green glass screen to approximately their original size, and they appear as positives, not negatives, so that photographs, charts, and maps are almost as usable as the original.

This library is something new in research tools. It grew from a desire within the company to have a usable, complete library of Rocky Mountain geology on hand. It is unique in its selection of material about a given area—the Rocky Mountains—and about given subjects—petroleum, sedimentary, and stratigraphic geology, and paleontology. It is unique also in its arrangement of material so that many pages of text are reproduced on one film transparency, and also in its "coding" and selection system.

Organization of the physical form of the library was made by considering the latest technologic developments in photographic processes and in sorting practices. Because of greater possibilities of detail illumination and better definition of illustration, transparent positive images are used.

A rapid means of sorting the cards is provided by the needle-sorting system. The number of categories needed for optimum separation was determined by the geologic subjects and the geologic areas covered. The sorting holes, about 1/16 of an inch in diameter, were made so that they could be punched into slots about one-fourth of an inch in length, in the long direction of the card. The cards are oriented vertically in the file, and the upper right corner is notched, to determine correct orientation of the individual cards.

Each card is numbered and filed according to the area its subject matter encompasses. Numbered areas within the greater Rocky Mountain region are indicated on a map accompanying the library. Areas are limited by prominent geological or geographical boundaries. The Rocky Mountain region has been interpreted to include structural basins bordering on the Rocky Mountains, and areas stratigraphically related to these. Articles dealing with larger portions of the Rocky Mountain region are included also and are coded into regional, geologically or geographically bounded areas.

In addition to the numbered breakdown of areas, letter designations—N, S, E, W, and C, for north, south, east, west, and central, indicate the portion of a numbered area involved. To further facilitate selection by area, a separate coding by states is used.

Geologic eras, periods, and Tertiary epochs are coded, if any of the information on the card is identified in terms of geologic time.

Eighty-seven geologic subjects are coded. A few of these are: structural contour maps, areal and tectonic maps, isopachous maps, lithofacies maps, structural and stratigraphic cross-sections or diagrams, measured sections and well logs, detrital sediments, paleoecology, paleontology, radioactive minerals, origin, migration, and accumulation of petroleum, trap descriptions, and oil analysis.

In selecting cards by subject, one may use as many qualifying coding categories as desired. For instance, one may select cards containing structural contour maps based on Pennsylvanian strata in the southwest part of the Big Horn basin. Furthermore, using the date-of-publication code, one could limit the cards selected to those containing articles published within any decade since 1910, or to those published before that year. If desired, the researcher may confine his selection to unpublished material by using another code and slot.

If a particular article is sought, a printed bibliography of the library lists, by author, all articles included in the library and gives the "call number" of each card. This call number is slotted on the card, so that the card may be selected by needle sorting.

In addition to being convenient, such a system also insures that no material will be misfiled areawise. The first two digits of the call number are the area designations of the card, and these are slotted along one edge of the card; a card out of position may be detected at once. Within a single area, cards need not be in order, because the needles readily select the proper cards, by subject, irrespective of their location in the group.

The uses of this type of library are many and varied. The Rocky Mountain library may be only a beginning—a pioneer, so to speak. Based on the demand, as indicated by the first effort, the library may be expanded to coverage of the continent, and even of the world. The principle behind it is applicable, too, in other sciences. The library's compactness makes it an ideal office or academic tool. Its sortability puts it far ahead of other libraries and filing systems, and its reproducibility makes it available to all. **—The End**

About the Author

JOHN CHRONIC is an assistant professor of geology at the University of Colorado, Boulder, Colo. He received a B.S. degree in petroleum engineering from the University of Tulsa in 1942 and an M.S. in geology at the University of Kansas in 1947. He received his Ph.D. in geology at Columbia University in 1949. In addition to his duties as a teacher, he is a consultant for Petroleum Research Corporation and helped develop the library described in this article.

Take a Look at Free World's 236 Major Oil Fields

Where are the present day major oil reserves? What type of structural sources are found in these fields? What type structure predominates? Here are the answers to these and other questions . . . taken from a study of all the Free World's major fields.

By G. M. KNEBEL and GUILLERMO RODRIGUES-ERASO
Standard Oil Company (New Jersey), New York City and Caracas, Venezuela

NORTH AMERICA leads the way in total number of major producing fields while the Middle East shows the highest average ultimate yield per field. And the true giants with reserves over 10 billion barrels are confined to the Middle East with the exception of one located in western Venezuela. Over 50 percent of the reserves of the major fields studied are located along the hinge lines of depositional basins.

"The Habitat of Oil in the Sedimentary Basin" was the central theme of the Annual meeting of the American Association of Petroleum Geologists held in New York during March 1955. Numerous papers were presented covering many of the producing basins of the world. As a follow-up to those presentations, this article offers a statistical study of the habitat of most of the world's ultimate oil discovered to date outside Soviet Russia and its affiliated countries.

For practical reasons, this study deals only with the so-called major fields, those fields having an ultimate recovery exceeding 100 million barrels. Ultimate recovery, as used in this paper, means total oil discovered to date, that is, present remaining reserves plus past production. During the study, it was found that 236 fields qualified as major oil fields. These fields are located in 42 basins and together account for 217 billion barrels of oil. This represents 82.5 percent of the known ultimate recovery of the free world of approximately 263 billion barrels. The remaining 17.5 percent, of 46 billion barrels, is scattered in thousands of smaller fields whose individual recoveries will not reach 100 million barrels.

From the above figures, it is apparent that any study involving the world's major oil fields carries considerable weight in view of the impressive aggregate ultimate recovery that these fields have. Consequently, these major accumulations provide the geologist with the easiest accessible means of studying the bulk of the world's oil found to date.

Statistics can be quite dull and meaningless unless they carry a message. It is hoped that the statistics presented herein will at least:

- **Make petroleum geologists more familiar with the location and distribution of the bulk of Free World oil.**
- **Present an over-all picture of the preferred localization of this oil from as many points of view, geologically or otherwise, as a general study of this kind will permit.**
- **Stimulate work and research seeking rational geological explanation for the patterns of distribution shown.**

The world's habitat of oil picture can be viewed from as many angles as there are relevant controlling geologic factors. In this statistical study, the information relating to the habitat of oil in the Free World's major oil fields will be presented on the basis of the following criteria:

1. Geographical Location
2. Basin Position
   Depositional Basin
   (a) Mobile Rim
   (b) Deep Basin
   (c) Hingeline
   (d) Shelf
   Present (Structural) Basin
   (a) Mobile Rim
   (b) Deep Basin
   (c) Hingeline
   (d) Shelf
   (e) Other
3. Type of Trap
   (a) Anticline
   (b) Fault
   (c) Unconformity
   (d) Reef
   (e) Other Stratigraphic
   (f) Combination
4. Lithology of Reservoir
   (a) Sand
   (b) Carbonates
   (c) Other Fracture
5. Geologic Age of Reservoir
   (a) Pleistocene-Pliocene
   (b) Miocene-Oligocene
   (c) Eocene-Faleocene
   (d) Mesozoic
   (e) Paleozoic
6. Gravity of crude
   (a) Light (above 30° API)
   (b) Medium (22°-30° API)
   (c) Heavy (below 22° API)
7. Chemical Base of Crude
   (a) Paraffinic
   (b) Mixed
   (c) Asphaltic
8. Subsurface Depth of Occurrence

(a) 0- 1000 ft.
(b) 1000- 2000 ft.
(c) 2000- 3000 ft.
(d) 3000- 4000 ft.
(e) 4000- 5000 ft.
(f) 5000- 6000 ft.
(g) 6000- 7000 ft.
(h) 7000- 8000 ft.
(i) 8000- 9000 ft.
(j) 9000-10,000 ft.
(k) 10,000-11,000 ft.
(l) 11,000-12,000 ft.
(m) over 12,000 ft.

9. Time of Discovery

Once a field was properly classified according to the subdivisions of the above scheme, the next step consisted in assigning ultimate reserves to every one of the classifications pertaining to each field. Finally, the allocated reserves figures of the individual fields were totaled for each basin in order to arrive at totals for each continent and for the free world as a whole. In addition, under each classification, the number of fields was also totaled in order to gain an idea of how many individual occurrences were responsible for the reserves calculated in the previous step.

1. GEOGRAPHICAL LOCATION

Before going into the geologic details of the study, consider a few generalities on the geographical location of these giant fields and the basins in which they occur as shown in the tables.

As the figures show, North America leads in total number of major fields while the Middle East shows the highest average ultimate yield per field. This table also indicates that 185 fields, or 82 percent, fall in Class I, the smallest bracket, of the breakdown having ultimate reserves of less than 500 million barrels each. The true giants with reserves over 10 billion barrels each are confined to the Middle East with the exception of one located in western Venezuela. In the Middle East 13 fields, or 56 percent of the total of 21 fields, have ultimates exceeding 1 billion barrels each, and of these, five fields, or 38 percent, have an ultimate yield in excess of 10 billion barrels.

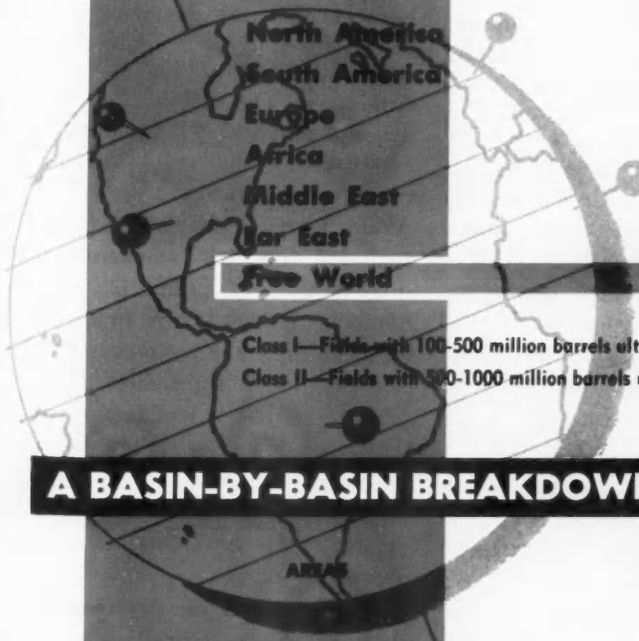
The world-wide distribution and relative importance of the privileged basins having major oil fields are shown also.

Only eight basins in the world have over 10 major fields each. It should be noted that 31 basins, or 74 percent of the total, belong to Class I having five or less major fields. Of the total of 42 basins having major oil fields only two, the Persian Gulf and the Gulf Coast, have more than 20 major fields among their petroleum accumulations.

2. BASIN POSITION

Position in depositional basin— Figure 1 shows schematically the four simplified portions of a basin which were used in this work, namely, the shelf, hingeline, deep

WHERE ARE FREE WORLD'S MAJOR OIL FIELDS?



AREAS	NUMBER OF MAJOR FIELDS TOTAL	CLASS I	CLASS II	CLASS III	CLASS IV	AVERAGE ULTIMATE*
North America	177	153	19	5	0	300
South America	28	22	5	0	1	730
Europe	1	1	0	0	0	120
Africa	1	1	0	0	0	200
Middle East	21	2	6	8	5	6700
Far East	8	6	1	1	0	520
Free World	236	185	31	14	6	920

Class I—Fields with 100-500 million barrels ultimate.
Class II—Fields with 500-1000 million barrels ultimate.
Class III—Fields with 1000-10,000 million barrels ultimate.
Class IV—Fields with over 10,000 million barrels ultimate.

* Millions of Barrels.

A BASIN-BY-BASIN BREAKDOWN . . .

AREAS	NUMBER OF BASINS TOTAL	CLASS I 0-5 Major Fields	CLASS II 5-10 Major Fields	CLASS III 10-20 Major Fields	CLASS IV Over 20 Major Fields
North America	28	20	2	5	1
South America	6	4	1	1	0
Europe	1	1	0	0	0
Africa	1	1	0	0	0
Middle East	1	0	0	0	1
Far East	5	5	0	0	0
Free World	42	31	3	6	2

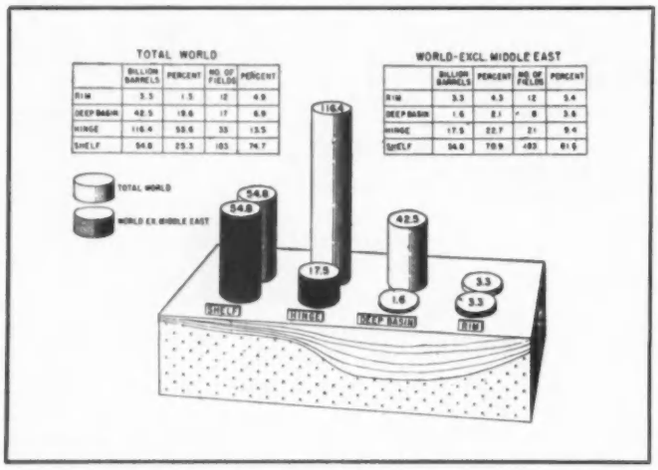


FIGURE 1—Habitat of oil in the Free World's major oil fields according to basin position in the depositional basin.

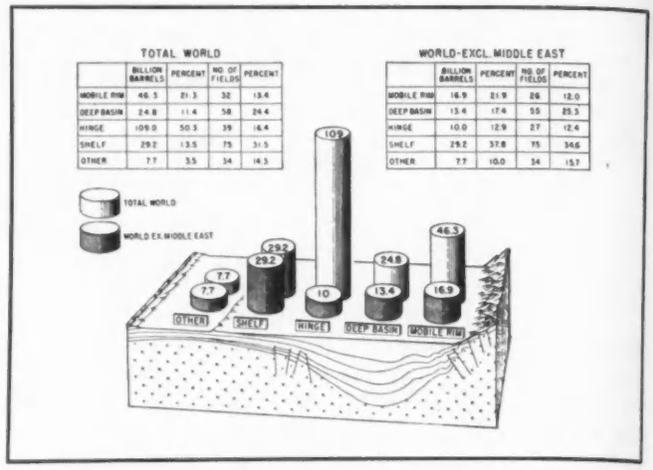


FIGURE 2—Habitat of oil in the Free World's major oil fields according to basin position in the present (structural) basin.

basin, and mobile rim. If a more elaborate breakdown had been used, the results would be more difficult to interpret even though they might more nearly conform to the architecture of basins as understood today.

There may be some question as to the basin position assigned to some of the fields. The authors believe that the selections made are reasonably correct and should be accepted until a more exhaustive study is made. It should be emphasized, however, that there is usually less room for argument regarding the fields' basin position in the present or structural basin. Therefore, the position in the structural basin is considered more reliable and should be the criterion used to indicate the basin habitat of oil.

In the figures and tabulations that follow, two sets of figures will be shown. One set applies to the Free World as a whole while the second will give the Free World's picture excluding the Middle East. This is necessary because the tremendous reserves of the Middle East often distort the picture of the habitat of oil in the other areas.

Figure 1 shows the distribution in the depositional basin of the ultimate oil discovered to date in the Free World's major oil fields. This figure shows that over 50 percent of the ultimate reserves of the major fields studied are located along the hingelines of the depositional basins. It should be noted, however, that if the prolific Middle East fields are excluded, the shelf becomes the leader in both ultimate oil and number of fields.

Fields located along rims of depositional basins are present in the Rocky Mountains and the Mid-Continent region of the U. S. and in the Orinoco Basin of Eastern Venezuela and Trinidad.

Deep-basin fields are more widespread than rim fields and occur in the Ardmore Basin of southern Oklahoma, some of the California basins, West Texas, and the Middle East.

Hingeline fields in North America are limited to the Alberta, Ardmore, Gulf Coast, and Appalachian basins. Important hingeline fields in South America are found in the Maracaibo Basin of Western Venezuela and the Comodoro Rivadavia Basin of Southern Argentina. The greatest bulk of the Middle East oil is localized along the hingeline of the Persian Gulf Basin. All of the known producing fields of southern Iraq, Kuwait, Saudi Arabia, Bahrain, and Qatar lie along the basin's hingeline with an estimated ultimate of close to 100 billion barrels.

Of the 42 basins having major fields, all but seven have fields along the shelf of the depositional basin. The three most important domestic areas from the standpoint of ultimate reserves from the shelf are the Gulf Coast, California, and West Texas. Elsewhere, important shelf reserves are found in the Alberta, Northeast Mexico, Maracaibo, Orinoco, and Central Sumatra basins.

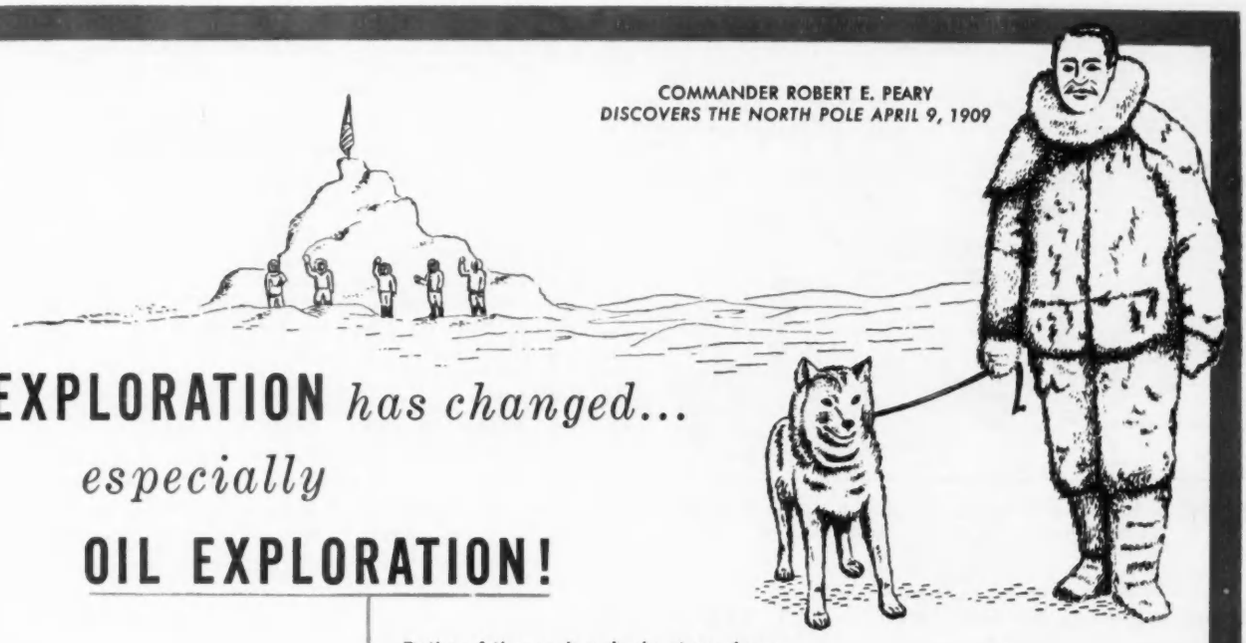
Position in the present (structural) basin—Figure 2 shows the basin habitat in the present or structural basin of the oil from the Free World's major oil fields. It should be noted that a fifth category has been added to the basin's subdivisions. Under this "other" category are classified those fields which cannot be associated with any present-day structural basin. The fields included here are all located in the U. S. and are all intimately related to large tectonic features such as the Central Kansas Uplift, Nemaha Ridge, Cincinnati Arch, etc.

Upon examining the figures, it can be seen that the hingeline still accounts for roughly 50 percent of the recoverable oil of the fields being considered. The mobile rim province has increased to 21 percent of the total at the expense of the reserves of both the deep basin and the shelf. Again here, if the Middle East is excluded, the shelf occurrence would predominate in both reserves and number of fields. It is to be noted, however, that the commanding position of the shelf province is not as marked here as it was in the case of the depositional basin. The difficulty of recognizing a hingeline in many present-day basins may account for the relatively small number of fields under the hinge.

Fields located on the mobile rim side of the present-day-structural basins are found chiefly in the following areas: Rocky Mountains, California, Venezuela, and Middle East.

Deep-basin fields occur mostly in Canada, the Mid-Continent area, California, and the Gulf Coast. Substantial reserves are also found in the deeper portions of the Persian Gulf Basin.

Hingeline fields in the U. S. are



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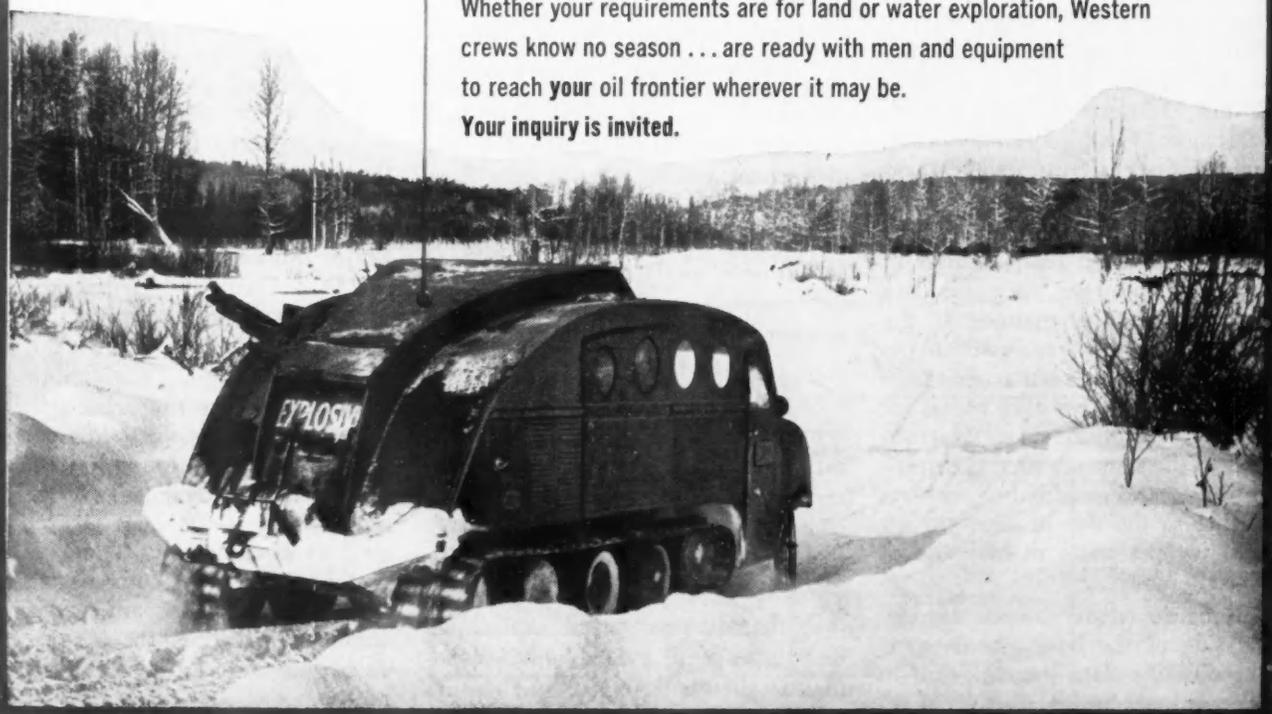

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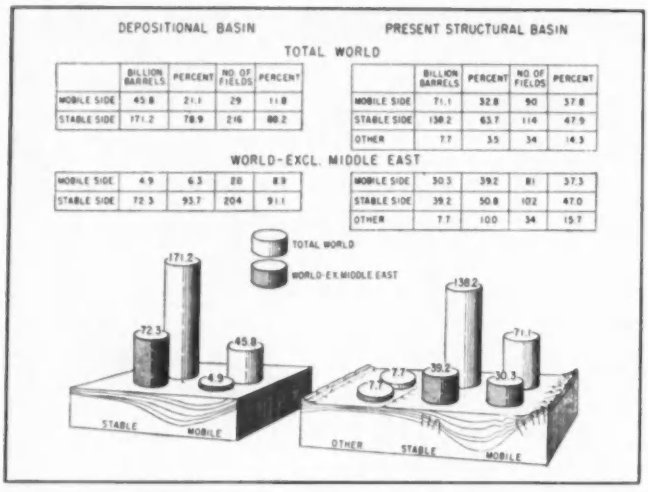


FIGURE 3—Habitat of oil in the Free World's major oil fields according to position in the stable or mobile side of basins.

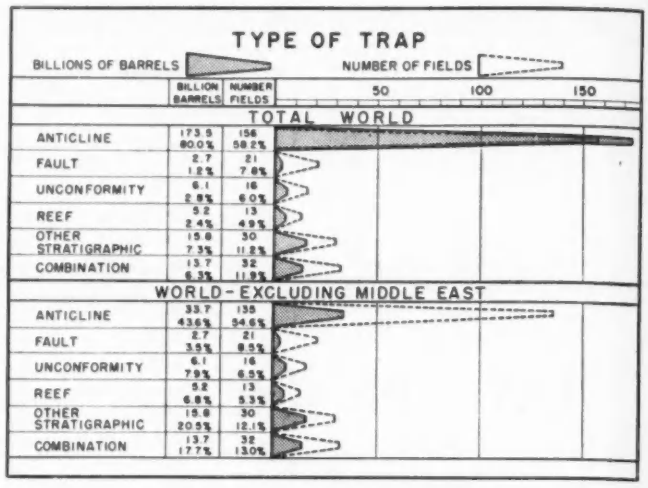


FIGURE 4—Habitat of oil in the Free World's major oil fields according to the type of trap responsible for the accumulation.

found mainly in the Gulf Coast and California. In South America both Venezuela and Argentina have important hingleline accumulations. The Middle East carries again close to 100 billion barrels of ultimate reserves in fields located along the hingeline of the Persian Gulf Basin.

Major-shelf fields are reported from 21 basins, of which the ones having in excess of 1 billion barrels ultimate, are listed in diminishing order: Gulf Coast, West Texas (Midland and Delaware basins), Northeast Mexico (Tampico Embayment), Alberta, Central Sumatra, Maracaibo, Los Angeles, and Orinoco.

In an attempt to summarize the previously discussed basin habitat of oil, Figure 3 presents the same data in a more simplified manner. In the preparation of this breakdown the shelf and hingleline occurrences have been grouped together and a total for the stable side of the basin was obtained. In the same manner, the deep-basin reserves were added to the ones belonging to the rim in order to get a total for the more mobile side of the basin.

This figure clearly shows that the stable side of the basins holds most of the oil. The data indicate that in the depositional basins, discovered reserves to date in the stable side are nearly four times those of the mobile side. In the present-day basins the mobile side has an improved position, but still the stable side leads the way by an approximate two to one margin. The fact that the above pattern of distribution holds true for both the depositional and structural basins, is considered significant.

3. TYPE OF TRAP

Figure 4 is a breakdown in billions of barrels and number of fields according to the type of trap responsible for the oil accumulations in the fields included in the study. It will be noticed the anticlinal traps are a clear leader accounting for 80 percent of the total oil found to date in the Free World's major oil fields. Many of these anticlines are faulted, but in all cases listed under "anticline;" the primary element causing the accumulation is the structural folding. The greatest anticlinal province is, of course, the Middle East where close to 140 billion barrels of oil have been found in a mere "handful" of anticlines, many of which were detected by simple "old fashioned" surface geology observations.

It is to be emphasized that anticline;" the primary element causing cent of the major fields' oil if the astronomical Middle East reserves are excluded. It is a moot question whether or not anticlines will be able to maintain their leadership in the years to come. It may well happen that the more advanced exploration techniques now available will eventually shift the balance, and the reserves that will be discovered in the more elusive stratigraphic traps might go beyond the amount now credited to anticlinal traps.

Most of the discovered Free World's ultimate oil is 30 degrees API gravity or lighter with misted asphaltic base oils predominating. The discovery of the Free World's major oil fields has been cyclic with ten-year intervals starting in 1917.

In addition to the Middle East, other anticlinal areas of importance are the California basins, the Central Basin Platform of West Texas, the Western Maracaibo Basin, and the basins of the Far East (Burma, Sumatra, and Borneo).

It is somewhat surprising that purely fault traps account only for 1.2 percent of the total oil of the world's major oil fields. The explanation probably lies in that many of the so-called fault traps are really combination traps, the fault being only one of the trapping elements. Major fault trap fields are limited to the Gulf Coast and Ardmore Basins in North America and to the Orinoco, Magdalena, and Talara basins of South America.

True unconformity fields again account for a disappointly low percentage of the total oil found in the major oil fields. Here again, it may be that most of the fields generally considered as unconformity accumulations really belong to the combination type of trap. The leader among the unconformity field is the East Texas field, with over 5 billion barrels ultimate.

An attempt was made to gain reliable information on the amount of oil occurring within 300 feet of an unconformity. Unfortunately, the figures secured are not conclusive as data on the oil located within 300 feet of an unconformity were not available for many fields. The incomplete information at hand on 130 fields indicates that 23.5 billion barrels are

found within 300 feet of an unconformity. This amount, 10.8 percent of the total, is surprisingly low and could no doubt be raised to at least 30 billion barrels should more information become available. This shows the importance of unconformities as places near which sizable oil reserves are likely to occur.

Reef fields hold 2.4 percent of the oil of major fields. The three more important areas producing from purely reef traps are the Devonian fields of the Alberta Basin of Canada, the Permian and Pennsylvanian reefs of West Texas and New Mexico, and the Golden Lane fields of Mexico.

Other stratigraphic traps such as pinchouts, shale-outs, asphalt seals, etc. are responsible for 7.3 percent of the 217 billion barrels of ultimate oil from the Free World's major oil fields. The most important fields of this type are located in the Alberta Basin, San Joaquin Valley, McAlester Basin, Midland and Delaware basins, and the Maracaibo and Orinoco basins.

Combination traps in which two or more trapping elements combine to form an effective barrier contain 6.3 percent of the total reserves of the Free World's major oil fields. Three major areas are responsible for over half of the reserves held in this type of trap. These areas in order of importance are: The Maracaibo Basin, the San Joaquin Valley, and the fields associated with the Nemaha Ridge of Kansas and Oklahoma.

4. LITHOLOGY OF RESERVOIR

The Free World picture from the standpoint of lithology of the reservoir rock is shown on Figure 5. These data are judged particularly significant in that they disprove the commonly held belief that most of the oil found to date is reservoired in limestones and dolomites. The results presented here show that sand reservoirs hold 59 percent of the oil found in major fields with carbonates holding almost the entire remaining 41 percent. Other fractured rocks such as shales and igneous or metamorphic rocks contain only 0.8 percent of the oil in major fields.

Major fields with sand reservoirs are found in all but two of the 42 basins of this study, the exception being the Williston Basin and the Cincinnati Arch. Carbonate production from major fields is found in 20 of the basins. Basins having over 1 billion barrels reserves from major carbonate fields are listed below in order of importance: Persian Gulf, West Texas, Northeast Mexico, Alberta and Maracaibo.

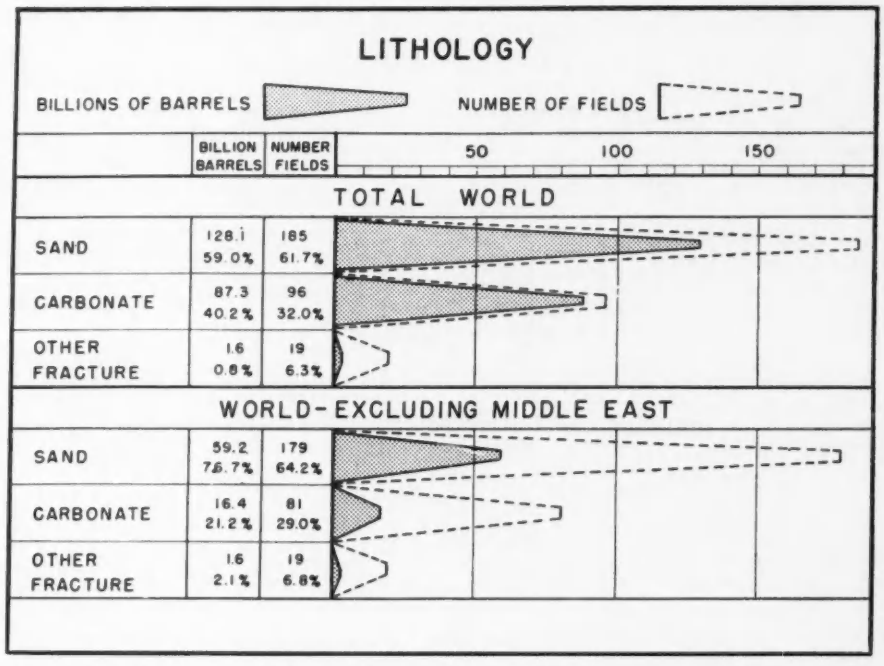


FIGURE 5—Habitat of oil in the Free World's major oil fields according to the lithology of the reservoir rock.

5. GEOLOGIC AGE OF RESERVOIR

The reserves breakdown according to the age of the producing formation is presented in Figure 6. The figures clearly indicate the predominant position of Mesozoic and Mio-Oligocene rocks as oil producers. Sediments belonging to these ages account together for over 80 percent of the total oil of the Free World's major oil fields. Excluding the Middle East, the Mio-Oligocene becomes the leader trailed by the Paleozoic and Mesozoic, with the Eocene-Paleocene and Plio-Pleistocene being virtually tied at the fourth place.

Major Plio-Pleistocene fields are

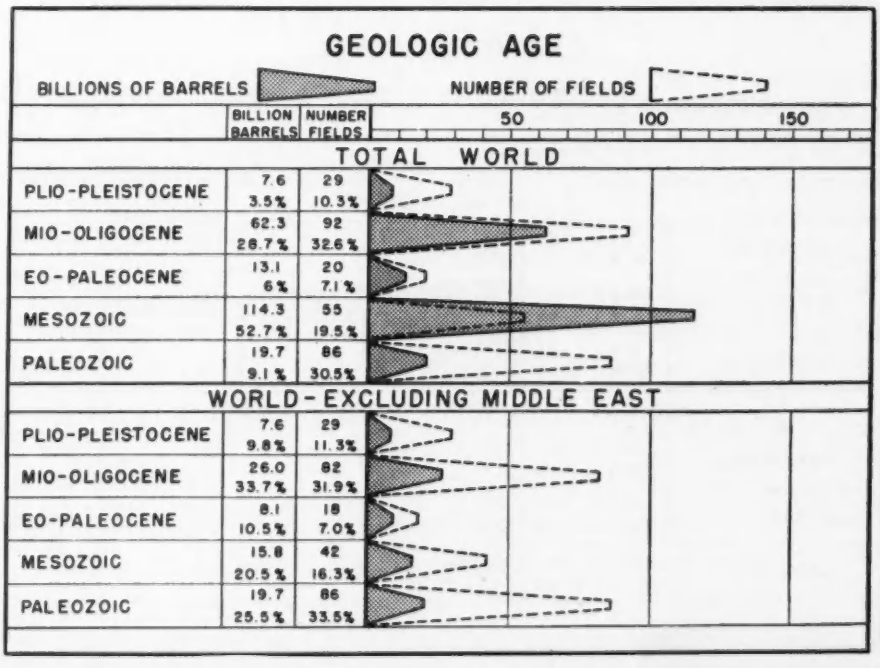


FIGURE 6—Habitat of oil in the Free World's major oil fields according to the geologic age of the producing formation.

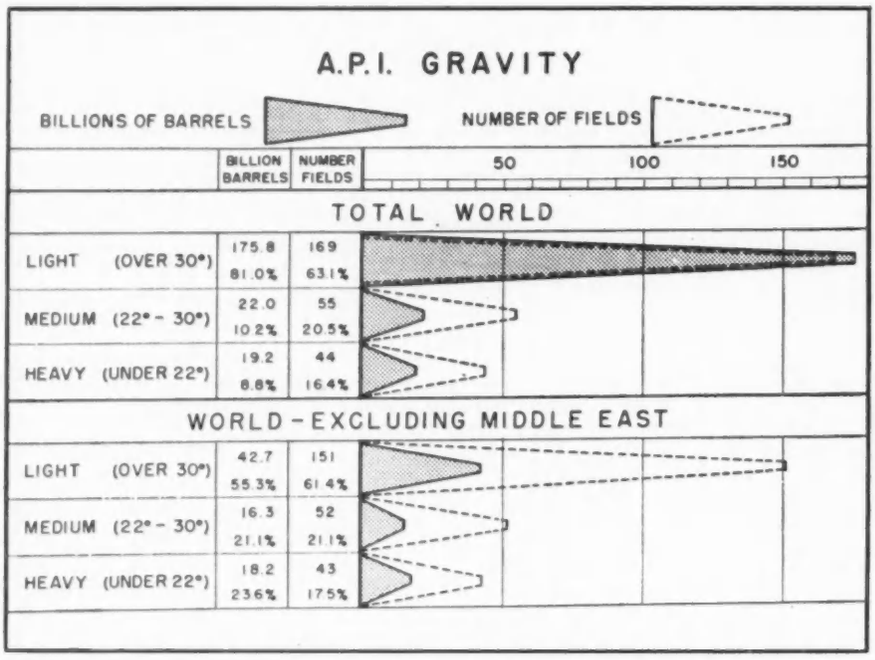


FIGURE 7—Habitat of oil in the Free World's major oil fields according to the API gravity of the crude.

restricted to California, the Gulf Coast, Eastern Venezuela, and one field in the Far East. Mio-Oligocene major fields are present in all the above areas, plus the Middle East, western Venezuela and Colombia. Eocene-Paleocene fields are more restricted in occurrence, the more important accumulations being located in the Maracaibo Basin, Middle East, Magdalena and Talara basins of Colombia and Peru, and the San Joaquin Valley and Gulf Coast of the U. S.

Mesozoic major fields are concentrated in the Middle East, Rocky Mountain province, Upper Gulf Coast, Mexico, western Venezuela, and Argentina. Out of the 114 billion barrels of Mesozoic oil in the major fields, 98 billion, or 86 percent, occurs in the Middle East producing countries.

Pallozoic production from major fields comes almost exclusively from the U. S. and Canada. The seven most prolific areas having ultimates surpassing 1 billion barrels, in their order of importance, are: Central Basin Platform and Midland and Delaware basins of West Texas, Alberta Basin, the Nemaha Ridge of Kansas and Oklahoma, the Seminole Uplift and Ardmore Basin of Oklahoma, and the Eastern Interior Basin of Illinois, Indiana and Kentucky.

A general idea about the relative richness of the individual fields of the various age groups considered can be gained by comparing percentage-wise the number of fields and the corresponding reserves of each particular age. For the world as a whole, the picture is as follows: Mesozoic fields lead with 19.5 percent of the total fields accounting for an overwhelming 52.7 percent of the total reserves. The tertiary fields with 50 percent of the total are responsible for 38.2 percent of the total reserves. Paleozoic fields, although accounting for 30.5 percent of the total number of fields, carry only 9.1 percent of the total reserves.

If the sizable Middle East fields are excluded, the Mesozoic fields still maintain the lead with 16.3 percent of the fields carrying 20.5 percent of the reserves; the Tertiary fields greatly improve their position now with 50.2 percent of the fields being credited with 54 percent of the reserves; the Paleozoic fields show some improvement with 33.5 percent of the fields carrying 25.5 percent of the total reserves.

The above comparisons conclusively show that worldwide on an average individual field basis, Mesozoic major fields are richer than either Paleozoic or Tertiary fields.

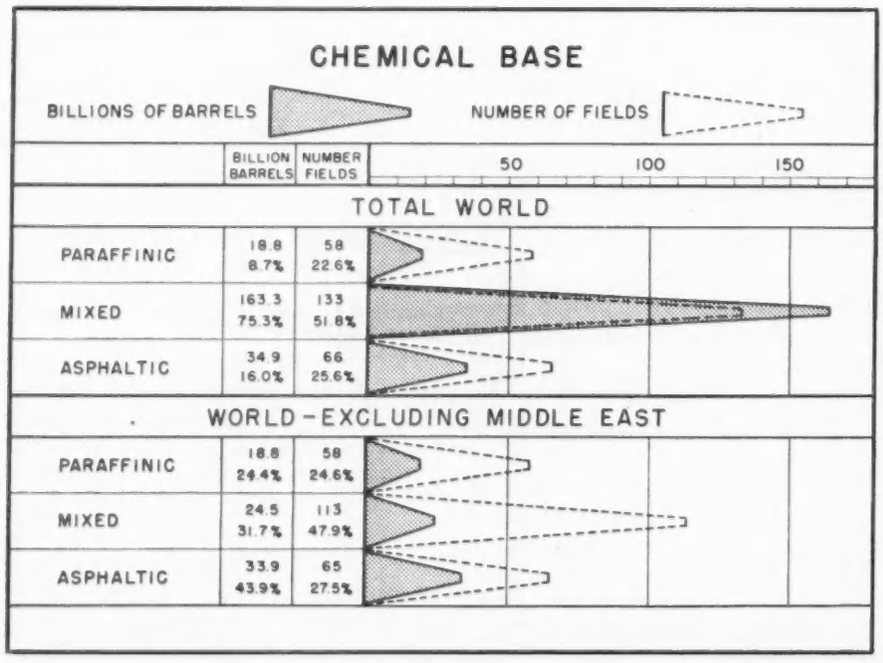
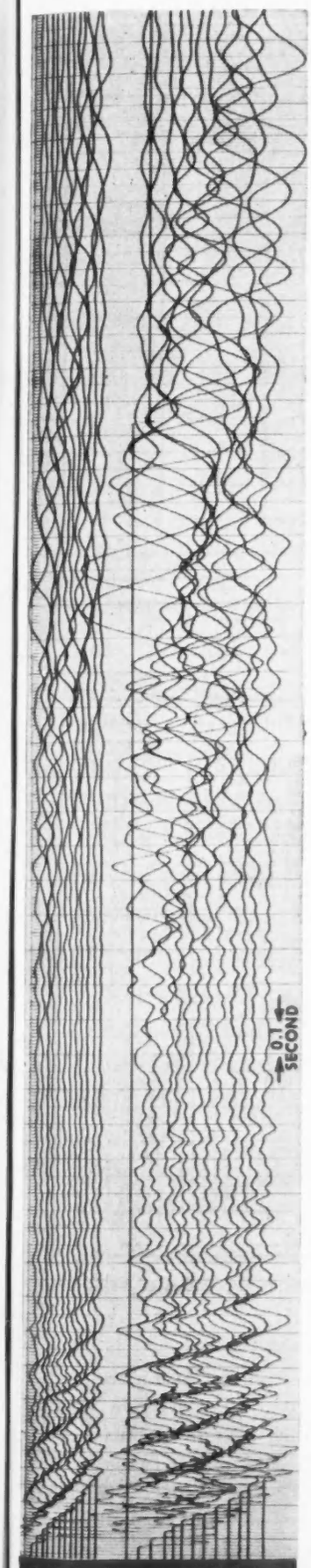


FIGURE 8—Habitat of oil in the Free World's major oil fields according to the chemical base of the crude.

6. API GRAVITY

As shown by the data on Figure 7, light oil predominates over medium and heavy reserves by a substantial margin. It should be emphasized that 91.2 percent of the total oil discovered in the world's major oil fields is lighter than 22° API gravity. Of interest is the fact that out of the 42 basins having major oil fields, only four (Magdalena, Mississippi Salt Dome, Salinas Valley, and Santa Maria) show no light oil reserves. Medium oil, major fields are located chiefly in California, Gulf Coast, Venezuela, and Middle East. Impor-



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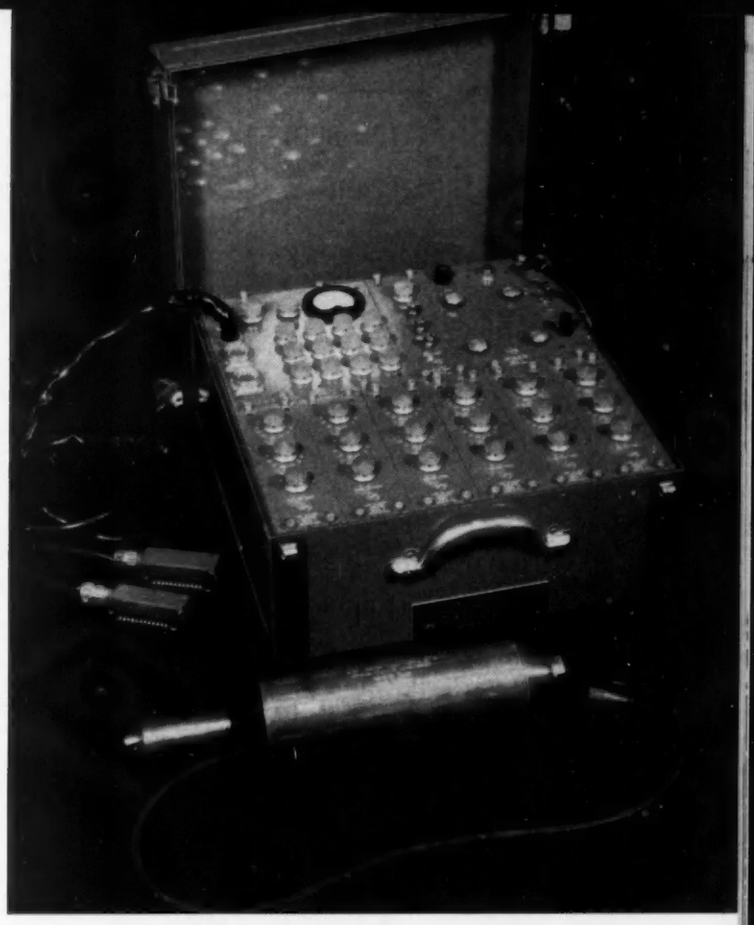

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For detailed information about the new VLF seismic refraction system, write for Bulletin No. S-308.

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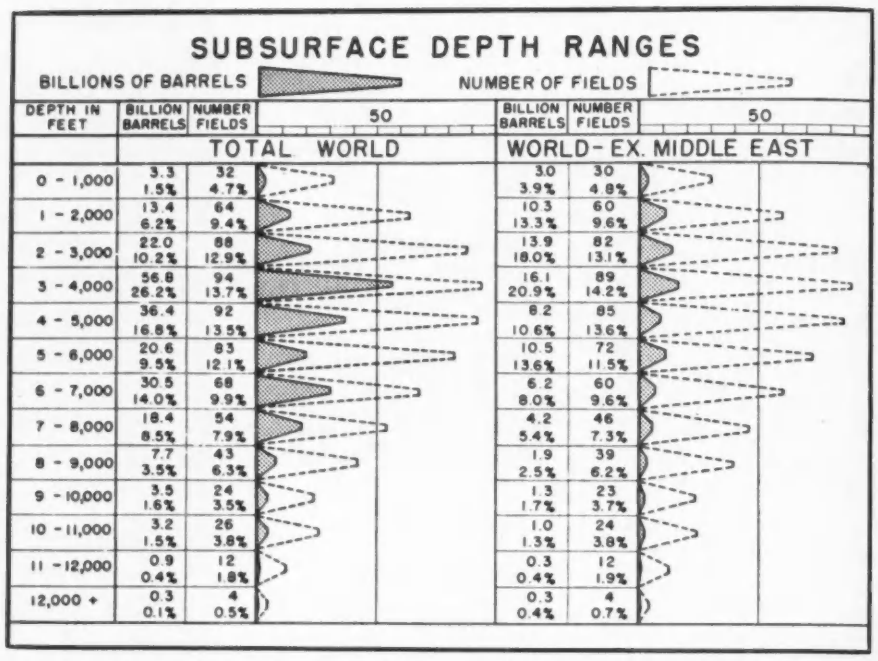

FIGURE 9—Habitat of oil in the Free World's major oil fields according to the subsurface depth of occurrence.

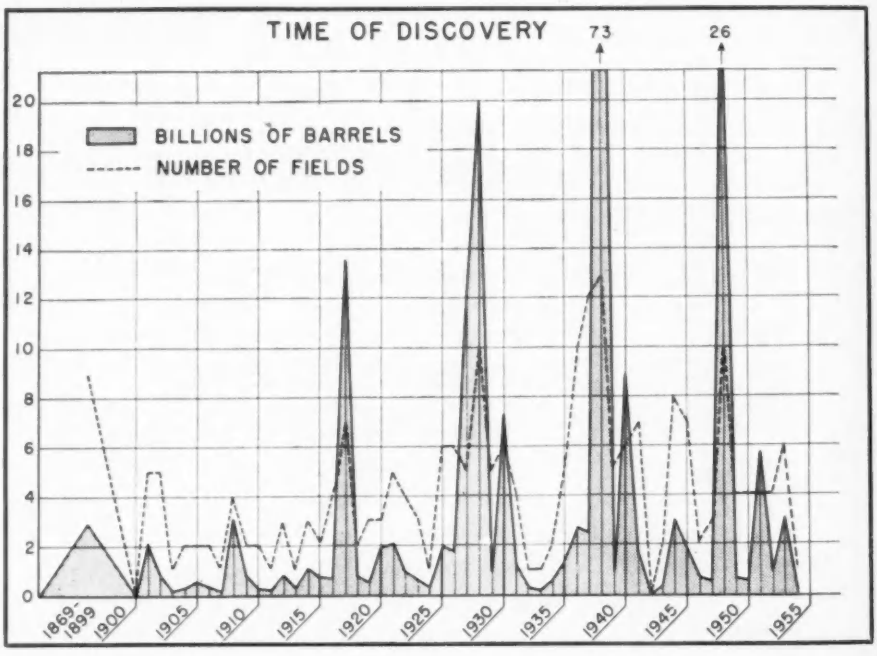

FIGURE 10—Chronological record of the discovery of the Free World's major oil fields.

tant heavy oil regions include Venezuela, California, and Mexico. Large reserves of the so-called tar oils were not included in the study inasmuch as these are considered non-commercial at the present time and accurate estimates as to their amount are largely lacking.

7. CHEMICAL BASE

The marked preponderance of mixed crudes shown in Figure 8 is due mainly to the Middle East reserves which almost exclusively belong to the mixed-base category. If the Middle East is excluded, the picture changes noticeably with asphaltic crudes leading the way, followed by the mixed and paraffinic oils. The largest asphaltic reserves are located in the Maracaibo Basin. The Gulf Coast and West Texas

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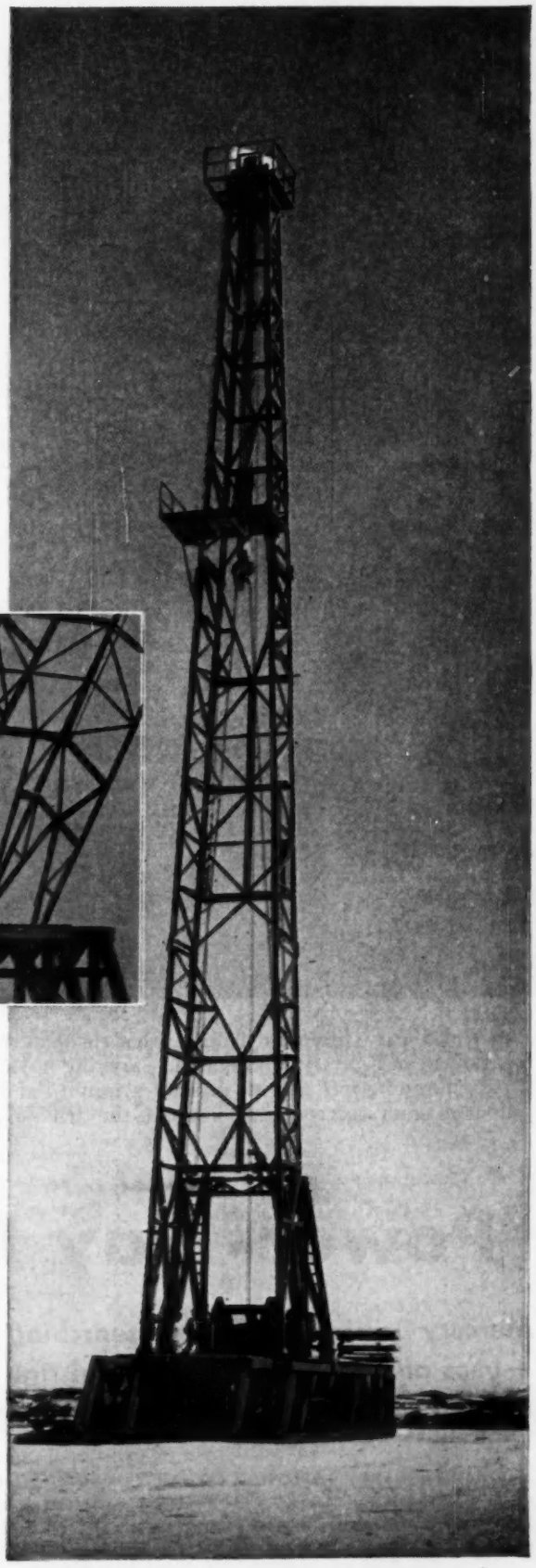
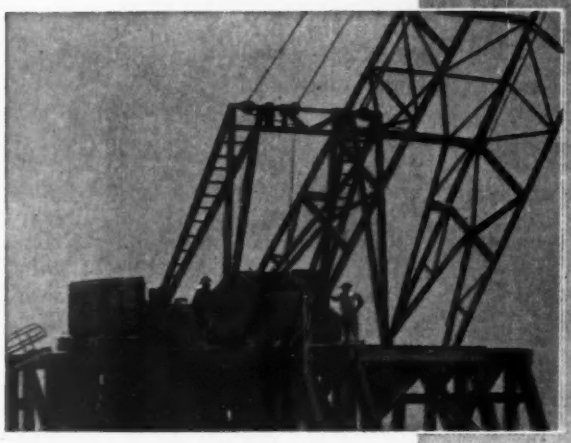
preferred everywhere by experienced drillers



Designed to stand up under hard usage and save time and money for oil well drillers, EMSCO MASTS offer a noteworthy combination of maximum portability, open-face design and ground-level assembly.



Drillers everywhere like the unit design of mast and superstructure which makes assembly on the ground easy and safe. Open-face design makes possible fast operation of various size traveling blocks. Emsco Masts can easily be moved in one piece or nested into sections of roadable widths. Highly suited for barge installation and in oil fields everywhere.

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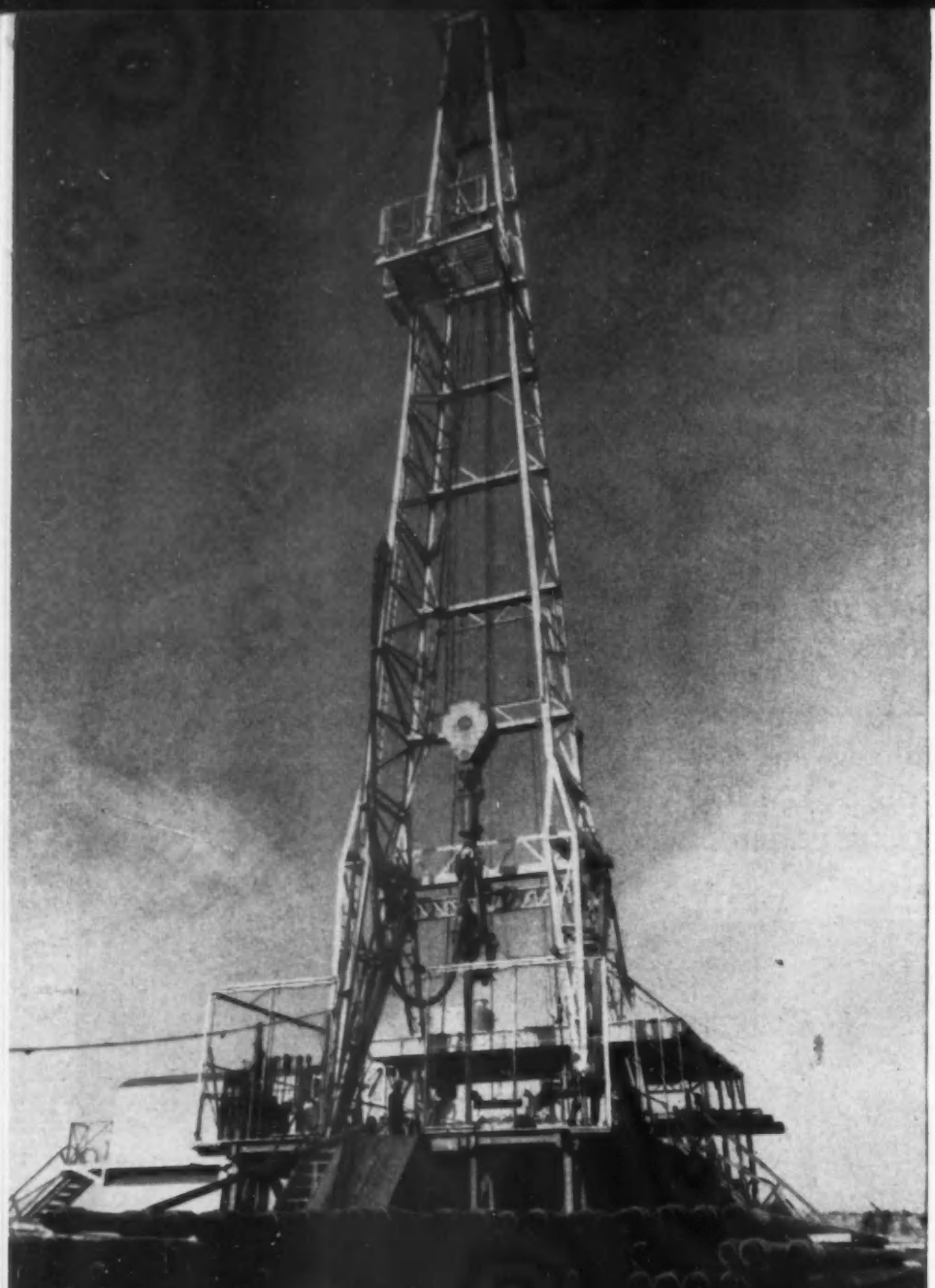

Designed for speed in drilling, this rig drilled 7,400 ft in 16 days at a location near Lindsay, Oklahoma. Carrying 40,000 lb of weight at the bit, it was pumping 641 gallons of mud a minute at 1,800 lb pump pressure to pulverize sand and rock and increase the drill's boring speed.

Roughnecks stab the tool joint into the waiting end as another length of drill pipe goes into the hole.

Power-Play For Oil

Mercury Drilling Company—searching for new reserves —uses one of the most powerful rigs ever built to thrust Pittsburgh Steel Company drill pipe into the earth.

Packing all the controlled power of a diesel locomotive, Mercury Drilling Company's Rig No. 2 is a giant among the nation's rotary drill rigs. This herculean rig, with its 142-ft high derrick now working in the oil-laden Golden Trend sands of Oklahoma, can bore its jet bits into the earth at rates up to 1,000 ft a day. It can bullseye a one-foot diameter target more than three miles underground.

Equipped with three 870 hp engines and three of the largest torque converters built, it can supply more than 2,400 hp to drive the rotary table and mud pumps. Its block, weighing nearly 8 tons, was specially designed for the rig.

Compact design throughout and a portable mud tank system give the rig mobility. On completing a hole, it can be knocked down, transported to a new location, set up and be drilling again in less than 2½ days with favorable weather.

When you have an investment of over a half-million dollars and operation costs up to $1,000 a day on a rig such as this, you can't afford to waste time.

Every feature of Mercury No. 2 is built for speed. From the power needed to carry heavy bit weight-loads, to the automatic slips for going in and out of the hole, it is equipped to drill more footage faster and more efficiently. Its mobility reduces down time between jobs.

Quality of the equipment and swift supply service are also essential to reaching pay fast. Here again Mercury saves time and expense.

This rig with all its equipment —including Pittsburgh Steel Company's seamless 4½ in. OD

Drill pipe, being measured in the rack, is fed into the hole length by length as the hole deepens. On a rig such as this it must withstand severe tension, compression, torsion and fatigue stresses as well as abrasive wear.

Grade E Range 2 drill pipe—is supplied by one of the independent distributors listed at right. Already a pace setter, it is hungrily churning after new footage records.

When operations must move fast, oil men with a lot at stake prefer the services of these distributors. Here's why:

Independent distributors are ready for action. Even the smallest item of equipment is available to your rig 24 hours a day, seven days a week. Well-stocked supply stores mean equipment can be on hand at the rig with least delay. You can count on them in emergencies.

Their service is flexible. The independents are personal friends to oil men they serve. Through long experience, they know the problems and can meet requirements without red tape and extra paper work. They are free from remote control and can make big decisions without wasting time.

Independent distributors help keep costs low. With all the extra service available, they keep their prices competitive. They can do this because of low overhead, and because their livelihood depends on meeting competition. The return Mr. Independent makes in business stays at home.

Their equipment is the best. Being independent, these distributors are free to select from the best equipment made, on the basis of performance and customers' requirements. They are backed by reputable manufacturers—such as Pittsburgh Steel Company, a producer of high quality seamless oil country goods for more than half a century.

Independents are accessible. The distributors at right have 141 stores covering all major oil fields in this country and some abroad. Yet each distributor individually concentrates his services in the home areas he is best qualified to serve.

Next time you need a string of drill pipe, casing or tubing, get the pipe of your choice through the distributor of your choice! Specify Pittsburgh Seamless!

For Fast, Personal Service

—these independent distributors who carry Pittsburgh Seamless drill pipe, oil well tubing, and casing are ready to meet your requirements.

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Houston Oil Field Material Co.
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Iverson Supply Company
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areas hold the largest reserves of paraffin-base oils.

It should be pointed out that the source data available on crude oil base for various areas are limited and the results shown may vary somewhat should more reliable data become available.

8. SUBSURFACE DEPTH OF OCCURRENCE

Figure 9 presents the subsurface depth distribution of oil, by 1000-foot increments, in the Free World's major oil fields. As the tabulation indicates, the richest subsurface depth interval is the 3000- to 4000-foot range which holds 26 percent of the total oil discovered in the Free World's major oil fields. It is noted that from this peak the values decrease in both directions, the decrease being more gradual toward the greater depths.

Of necessity, some of the figures that went into these depth computations must be considered as approximates only, since in some areas the necessary geological details were not available.

It is to be expected that the deeper picture will probably improve with time as more and deeper wildcats are drilled. However, this is the depth habitat of oil as it exists today. There must be some reason why the bulk of our oil, 85 percent, occurs at depths between 2000 and 8000 feet. Any answer as to the underlying cause for such distribution would be a contribution toward a better understanding of the processes of oil generation and accumulation.

9. TIME OF DISCOVERY

Figure 10 shows the number of major fields and the amount of oil discovered on a yearly basis since 1900. It is interesting to note the 10-year cycle of major discoveries beginning with the Bolivar Coastal fields of Western Venezuela in 1917. The peak discovery year with 73 billion barrels occurred in 1938 with the discovery of the Burgan field of Kuwait. Small amounts of oil were discovered during the economic depression of the early thirties following the discovery of the East Texas field and again during the inactive period of World War II. The values for the years since 1950 will probably move upward as those new fields become properly evaluated.

ACKNOWLEDGMENT

This work was published in the April issue of the *AAPG Bulletin*.

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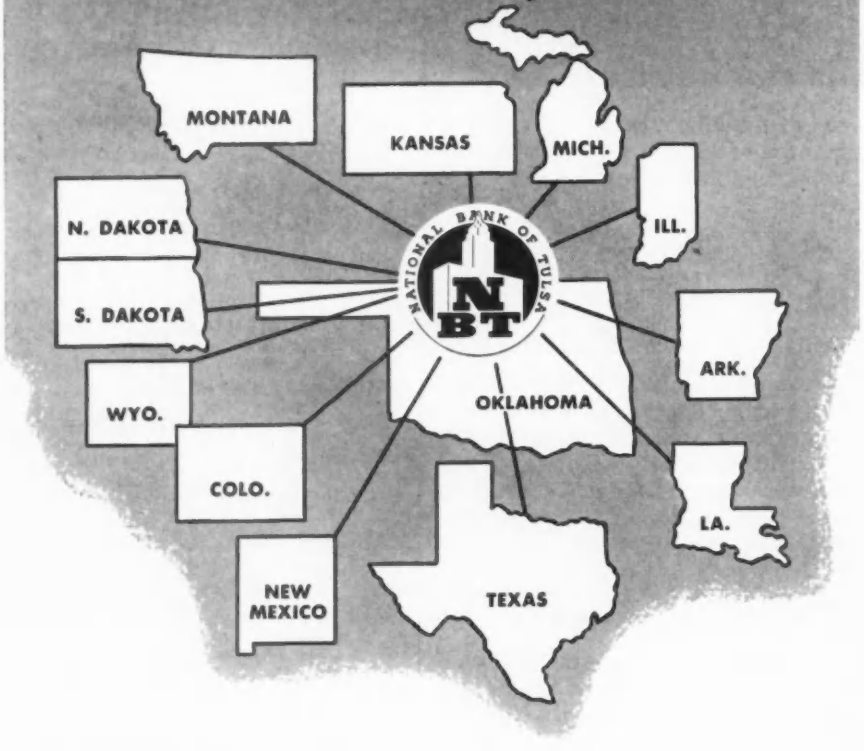

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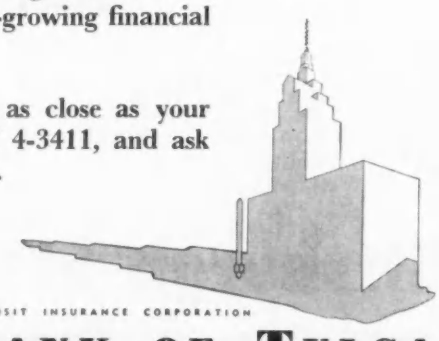

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What can we say?

The portable recorder shown on page 143 of the April issue of WORLD OIL is illustrated in an improper position. Above is the proper position of the instrument.

Part 2 of "North Dakota's Nesson Anticline" by W. M. Laird and C. B. Folsom will appear in a future issue of WORLD OIL.

What Factors Are Contributing To Increased Drilling Rates?

Here's how the drilling industry has increased penetration rates during the past few years without basic or revolutionary changes. Continuous improvement of operating techniques, materials and equipment has done the job. And continued use of the factors known to produce increased drilling rates promises further improvements in rig performance.

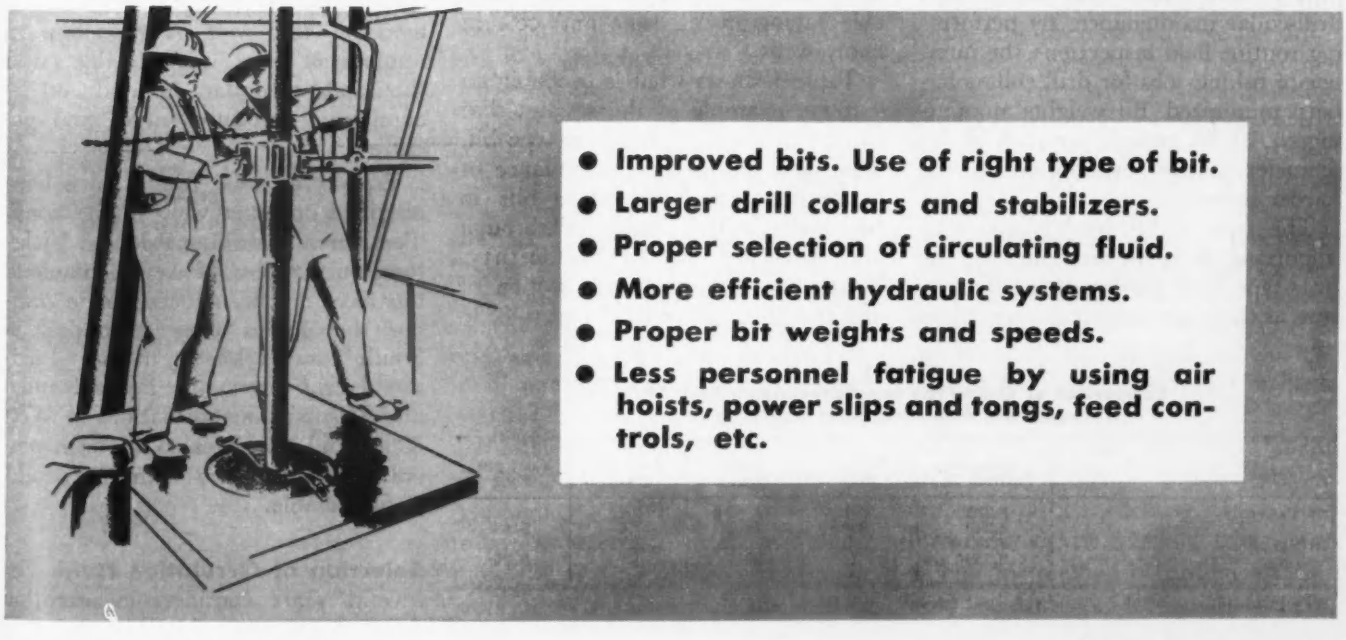
By W. R. WARDROUP, Humble Oil & Refining Company, Midland, Texas
and **GEORGE E. CANNON,** Humble Oil & Refining Company, Houston

THE RATE OF drilling in the U. S. has steadily increased the past few years. Some of the major factors which have contributed to improved rig performance are improved bits and the use of more bit weight, improvements in circulating fluids, and more efficient utilization of hydraulic horsepower.

In 1950 the average footage per rig year in the U. S. amounted to 35,369 feet and increased to 45,200 feet in 1954. This improvement has not resulted in reduced well cost nor reduced footage cost. The upward trend in well cost could be halted or reversed if more careful consideration was given to some of the more basic factors which effect the rate of drilling and the use of specialized equipment and techniques developed during recent years.

Bits and Drill Collars. Improvements in bit designs and materials have contributed considerably to the increased drilling rate during the past

Wider application of these factors will increase penetration rates . . .



- **Improved bits. Use of right type of bit.**
- **Larger drill collars and stabilizers.**
- **Proper selection of circulating fluid.**
- **More efficient hydraulic systems.**
- **Proper bit weights and speeds.**
- **Less personnel fatigue by using air hoists, power slips and tongs, feed controls, etc.**

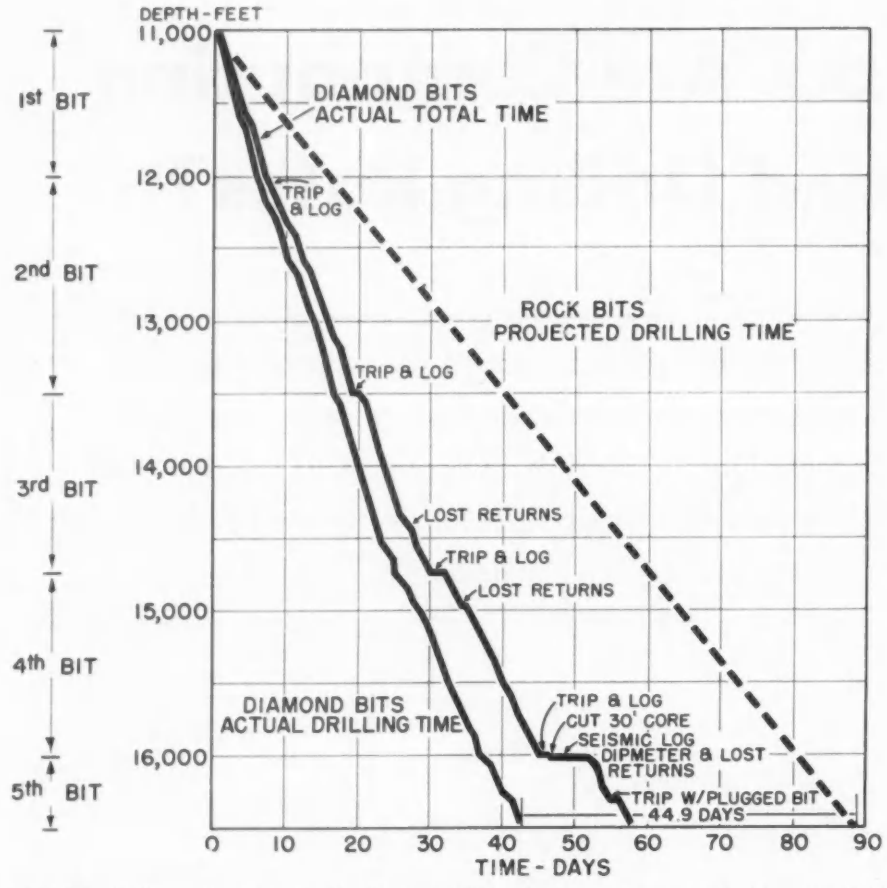


FIGURE 1—Drilling rate obtained with diamond drilling bits in the Armstrong 8, Armstrong field, Kenedy County, Texas.

few years. The use of large drill collars and stabilizers to minimize the rate of hole deviation has allowed more weight to be applied to the bit. In many areas, it is standard practice to use 6-inch collars in a 6¾-inch hole, 7-inch collars in a 7⅞-inch hole, and 8-inch collars in an 8¾-inch hole. The use of increased numbers of drill collars has been possible through improved drill-collar joint design and drill-collar maintenance. By performing routine field inspections, the number of fishing jobs for drill collars has been minimized. Bit weights amounting to 10,000 pound per inch of bit diameter is not uncommon in the harder formations.

The type of bit used is also very important. It is unfortunate that the drag-type bit is passing out of the picture as there are numerous formations and areas where other type bits have not been able to compete with the rates obtained with drag bits. The judicious use of what might be termed special bits has contributed to the improvement in drilling rate during recent years. One of the so-called special-type bits is the chert bit. Although not a cure-all for hard-rock drilling, its use has gained in popularity and has resulted in considerable saving in rig time and cost in many wells.

Table 1 shows what is probably an extreme example of the savings that can be made with the chert-type bit. This table shows the performance of conventional and chert-type bits in two wells drilled in the Yarbrough and Allen field in Ector County, Texas. In drilling a chert section of 106 feet from about 8230 feet to 8336 feet, a total of 20 conventional bits was required in one well as compared to one chert-type bit in an offset well. The cost per foot was reduced from $143 when conventional bits were used to $25 in the well using the chert bit.

TABLE 1
Comparison of Chert-Type and Conventional Rock Bits
Yarbrough and Allen Field, Ector County, Texas

	Interval Drilled, Ft.	No. of Bits	Total Hours	Feet per Hour	Cost per Foot
Conventional	8,233 8,339	20*	74¼	1.4	$143
Chert type	8,230 8,336	1	26	4.1	$ 25

* 17 Reamers.

Another type of special bit which is gaining in popularity is the diamond drilling bit. The diamond drilling bit has proved most successful in the smaller sizes, i.e., 7-inch OD or less. There is a great deal to be learned about the type of formations in which diamond drill bits can be most successfully employed. Unusual as it might seem, there is some property other than formation hardness which appears to be the controlling factor in considering the use of diamond drill bits.

Figure 1 shows the drilling rate obtained with diamond drilling bits in the Armstrong 8, Armstrong field, Kenedy County, Texas. Four 6⅜-inch diamond drill bits were used in drilling medium-hard Frio and Vicksburg formations from 11,000 to 16,000 feet. The fifth bit used from 16,000 to 16,497 feet was left in the hole. Each of the first four bits was pulled only because well logs were desired and not because the bits were dull. Figure 1 also shows an estimated penetration rate using conventional rock bits based on experience in the area, and it is seen that 45 rig days were saved by using diamond bits. It is estimated that 84 conventional rock bits would have been required to drill the interval. Time on bottom was 86 percent as compared to 40 to 45 percent when using conventional bits. An 18-pound per gallon mud was used on this well. A reduction in number of trips undoubtedly saved thousands of dollars in mud cost by eliminating pressure surges and gas cutting.

Equally as good results have been obtained on other wells in the South Texas area in drilling Frio and Vicksburg formations. However, diamond bits have not been successful in drilling the Travis Peak formation in South Texas. Likewise, the use of diamond drill bits in the Pennsylvanian and Mississippian formations in West Texas and New Mexico has been generally unsatisfactory with the results unpredictable.

Selection of Circulation Fluid. For several years considerable attention

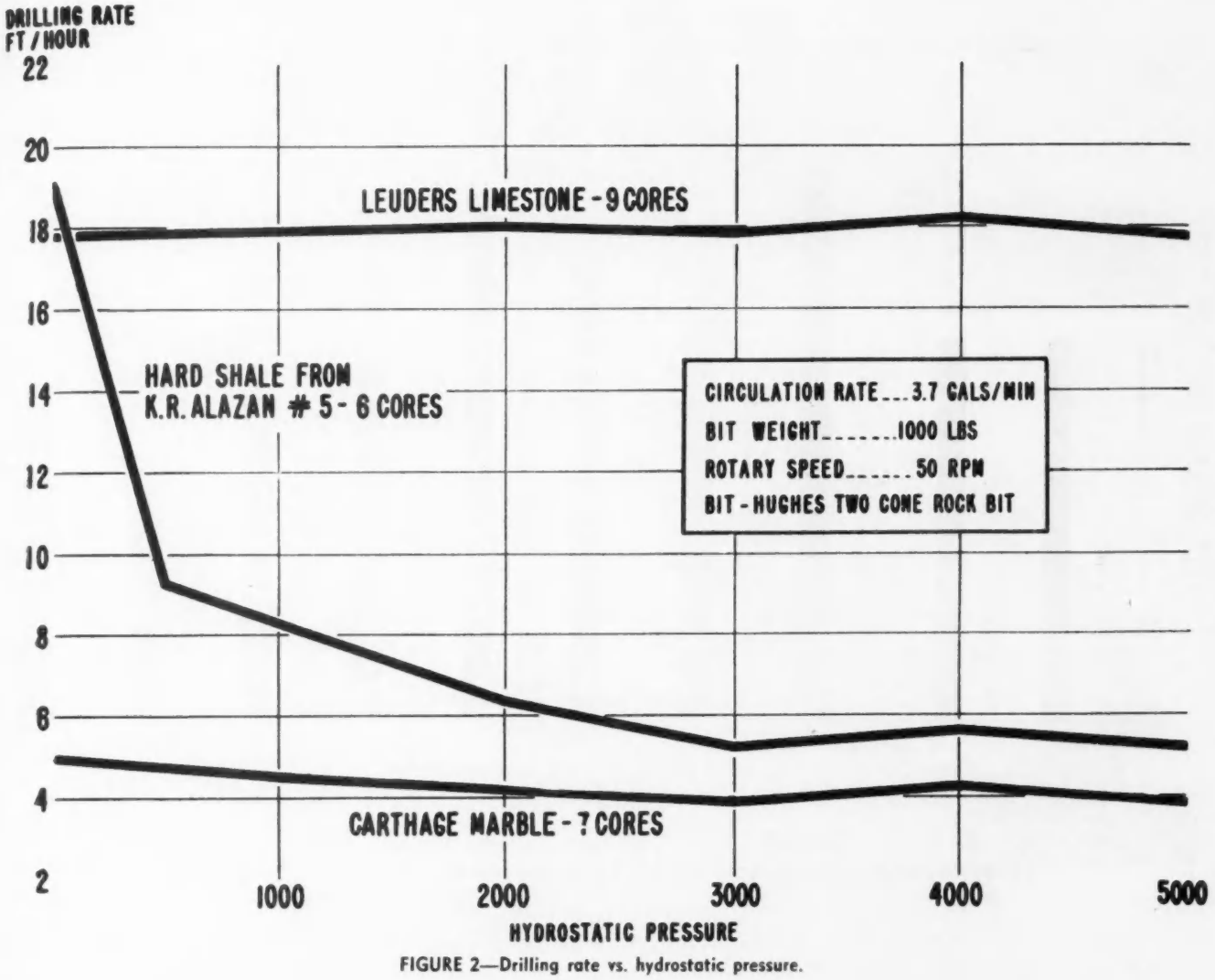


FIGURE 2—Drilling rate vs. hydrostatic pressure.

was given to the design of the hydraulic system and its effect on rate of penetration. It was well-recognized that fluid properties played an important part in rate of penetration. More recently this has been receiving more attention.

There has been much discussion about the effect of mud density on drilling rate. The reduction obtained in drilling rate as the mud density increases has been attributed to several things. Field and laboratory experiments indicate that density change alone is not the controlling factor and that other properties which accompany density changes and are not now measured will have to be investigated.

TABLE 2
Effect of Variation in Mud Density on Drilling Rate
Georgia B. King B-2, Means District, Andrews County, Texas

Hole Size—8¾ inch
Bit Weight—68,000 lb.
Circulation Rate—625 gpm
Formation—San Andres Dolomite
Depth—4,800 ft. to 5,400 ft.

Mud Weight, Lb. per Gal.	Relative Drilling Rate Percent
Water	100
8.9	82
9.23	78
9.6	72
9.6	76
10.1	73
10.5	62
11.2	57

Table 2 shows the results of a series of tests conducted at the Georgia B. King B-2, Andrews County, Texas, in which the mud density was varied from 8.9 to 11.2 pound per gallon. During the tests, bit weight, rotary speed, and circulating rate were maintained constant at the values shown on Table 2. In this series of tests only small batches (75 barrels of each weight mud) were used, and the drilling rate was accurately recorded as the mud was discharged from the bit. Assuming the drilling rate with water to be 100 percent, the data in Table 2 show the relative drilling rate to be reduced to 57 percent as the drilling mud weight was increased to 11.2 pounds per gallon. In these tests, the volume of mud was such that the change in the hydrostatic pressure on the formation was insignificant.

In some formations, increasing the hydrostatic pressure may reduce drilling rate. However, these pressure effects will vary with the permeability and perhaps other properties of the formation. Figure 2 shows the results obtained in the laboratory with three different types of formations. The very permeable Lueders limestone was not effected by increasing the pressure. However, there was considerable reduction in the drilling rate as the pressure was increased on less permeable Frio shale and Carthage marble.

During the past two years there have been numerous articles written on air and gas drilling. It is unfortunate there are so few areas where this method of drilling can be used because of formation waters.

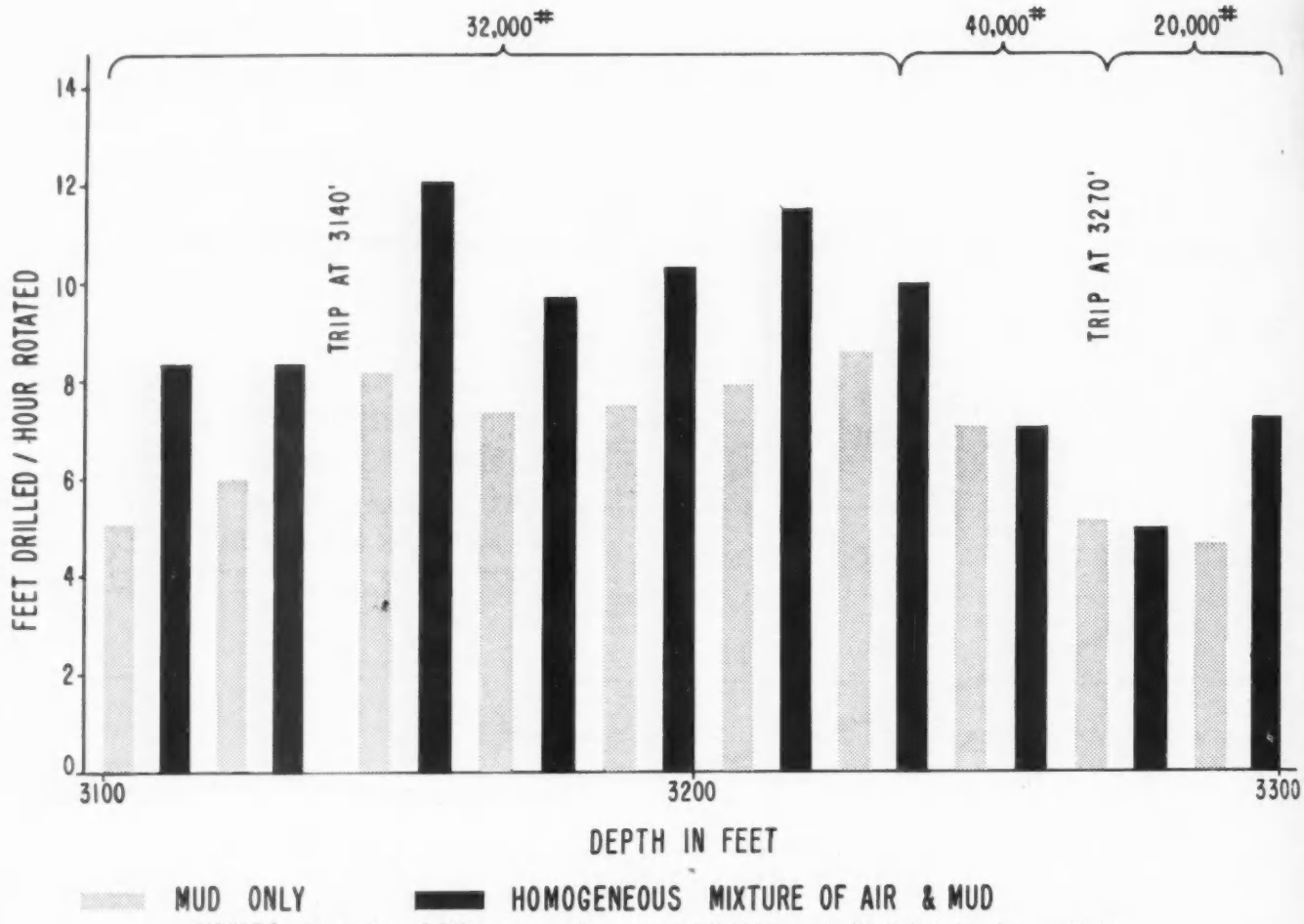


FIGURE 3—Comparison of drilling rate-mud vs. aereated fluid Huapache Oil Unit 1, Lea County, N. M.

There is much-needed research to be done on the problem of shutting off formation waters in order that the air or gas method of drilling may be extended. In Humble's operations air or gas drilling has been used successfully in North Texas, West Texas, Southwest Texas, and New Mexico. The most outstanding results Humble has obtained using gas drilling is in Val Verde County, Southwest Texas, the results of which are given in Table 3. This table shows that in drilling comparable formations from approximately 1500 to 9500 feet, the use of gas instead of mud as the circulating fluid saved 40.6 rotating days and 107 rock bits. The wells compared are located about three miles apart.

In some areas it is impossible to use air or gas as the drilling fluid and aerated mud or water may be used. An increased drilling rate may be obtained as compared to using mud or water. Humble has had very little experience with aerated-mud drilling. However, controlled tests in one well have shown that improvements in drilling rate can be obtained. Figure 3 shows the data obtained in the Huapache Oil Unit No. 1, New Mexico, when alternate 10-foot sections were drilled using mud and air-mud mixture. Because approximately 20 minutes were required for a complete circulation cycle, only the last 5 feet of each 10-foot interval drilled were considered for this comparison. An increase in penetration rate of 23.6 percent was realized over the entire test section of hard limestone when an air-mud mixture was used instead of mud.

We are all familiar with the increased penetration rates that can be obtained by using water in place of mud whenever possible, using a low-solid-content drilling mud and using oil emulsions in either mud or water. Generally, improvements in drilling rate and bit life are noted regardless of the type of bit being used or the formation penetrated. Until recently

TABLE 3

Comparison of Gas vs. Mud Drilling
Vinegarone Field—Val Verde County, Texas

Total Days	Interval, Ft.	Footage Drilled	Hours Rotated	Ft. Drilled per Hour Rotated	Footage per Bit	No. of Bits Used
WELL NO. 1—GAS OPERATIONS						
22.0	1,581–9,500	7,919	224.25	35.3	377	21
14.0	5,920–9,500	3,580	113.5	31.5	256	14
WELL NO. 2—MUD OPERATIONS						
57	5,999–9,488	3,489	854.25	4.1	47	74
WELL NO. 3—MUD OPERATIONS						
80	1,500–9,504	8,004	1,198.0	6.7	62	128

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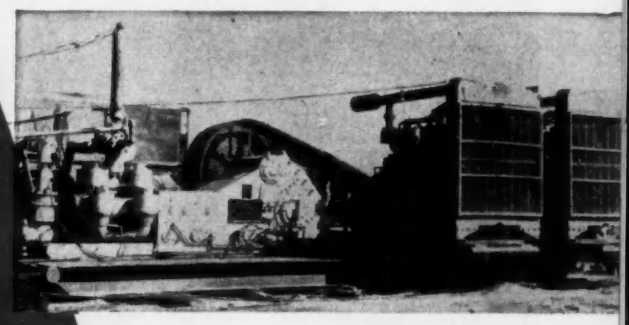
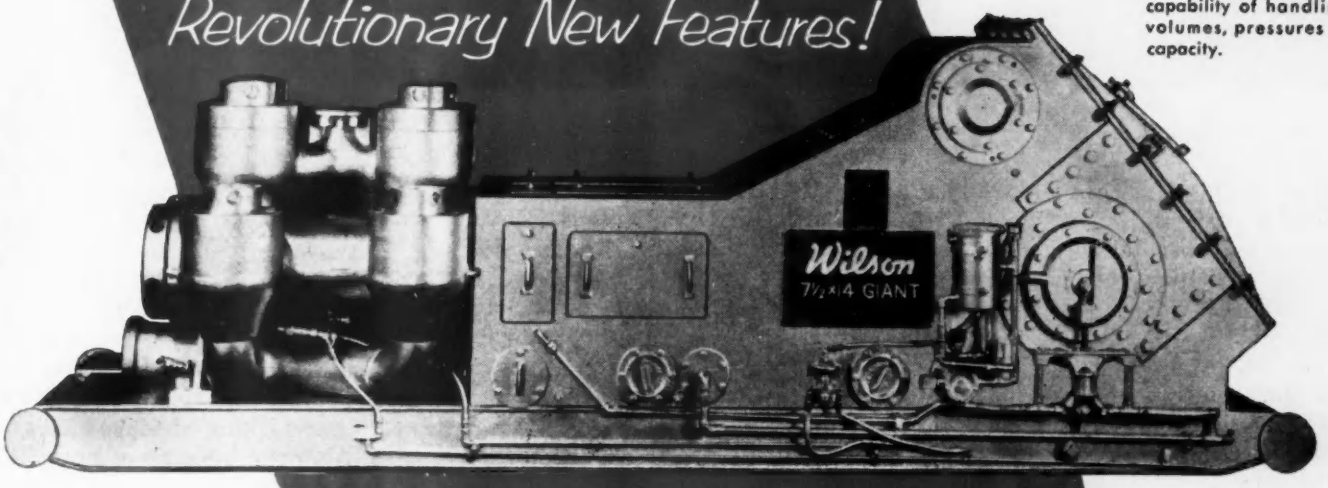


Photo of Wilson Pump on location. Note size in comparison to the engines. This pump is compact in design and construction, with the capability of handling high volumes, pressures and HP capacity.



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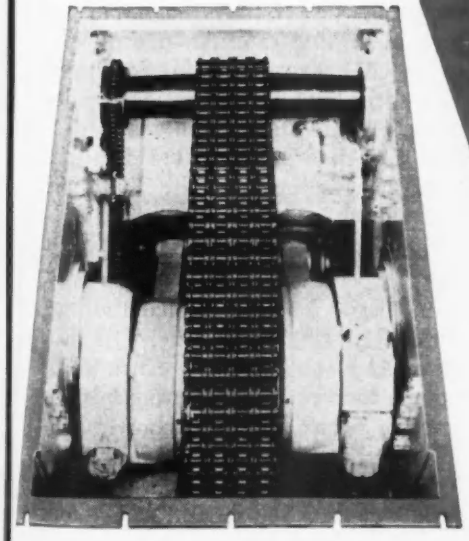

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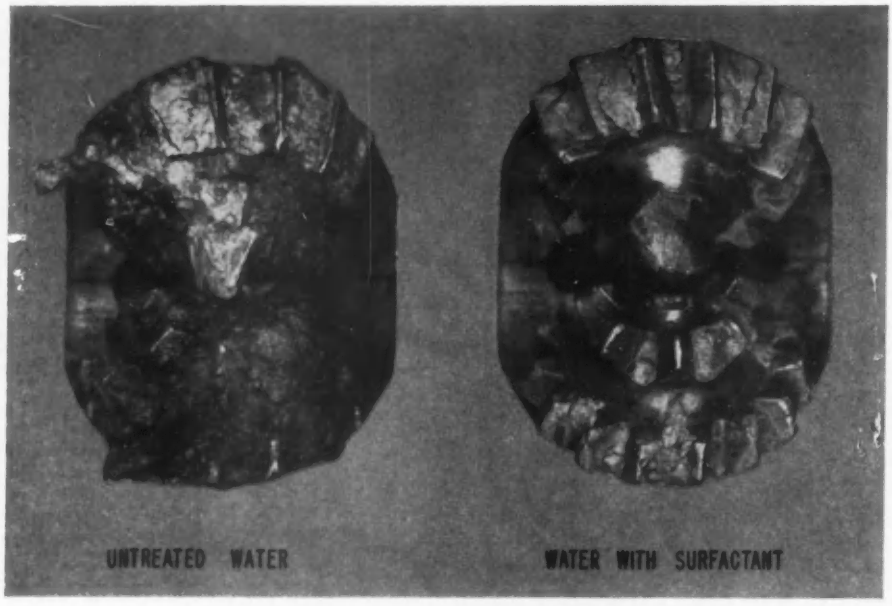


FIGURE 4—Bit-cleansing action.

it was assumed that the ultimate had been achieved as far as liquids were concerned when clear water was used as the circulating medium.

However, tests by several operators have shown that the performance of rock bits can be improved by the use of surfactant materials in the water. The mechanism by which bit performance is improved by the use of surfactant materials is not clearly understood, and a large amount of research work remains to be done on this problem. Some idea of what might be happening is illustrated by Figure 4, which is a picture of a laboratory bit used to drill hard shale.

The balled-up bit shown on the left was used with fresh water, and the clean bit shown on the right was used in connection with a surfactant material in the water. Table 4 shows field data obtained using two types of surfactant materials, i.e., the anionic or negative-charged particle and the non-ionic or neutral particle. In the first tests in the Hutex Devonian field, the use of the anionic surfactant resulted in improved bit life, 214 feet per bit to 346 feet per bit; increased penetration rate—20.71 feet per hour to 23.88 feet per hour; and reduced the number of bits from 6.4 to 4 required to drill the 1385 feet of test section.

The test was continued using a nonionic material and no improvement in bit performance was observed. However, in another series of tests in the Dean Devonian area of Lea County, New Mexico, using the nonionic surfactant, the number of bits required to drill a 4800-foot section was reduced from 57.6 to 42; footage per bit was increased from 83.8 to 115.2; and drilling rate was increased from 10.43 feet per hour to 12.65 feet per hour. The use of surfactant materials offers a most promising approach to increasing drilling rate where liquids are used and may also have application in air or gas drilling.

TABLE 4
Effect of Surfactant Materials on Bit Performance

	Drilling Fluid	INTERVAL, FT. From	To	Footage	No. Bits Required	Feet per Bit	Rotating Time Hours	Footage per Hour
1. HUTEX DEVONIAN FIELD—ANDREWS COUNTY, TEXAS								
Average 7 Wells	Water	5,182	6,552	1,370	6.4	214	66.14	20.71
1 Well	Surfactant*	5,108	6,493	1,385	4	346	58.00	23.88
Average 7 Wells	Water	6,552	7,689	1,137	5	227	56.43	20.15
1 Well	Surfactant†	6,493	7,611	1,118	5	224	60.00	18.63
2. DEAN DEVONIAN AREA—LEA COUNTY, NEW MEXICO								
Average 5 Wells	Water	4,963	9,760	4,827	57.6	83.8	462.75	10.43
1 Well	Surfactant†	4,750	9,590	4,840	42	115.2	382.75	12.65

* Anionic Type. † Nonionic Type.

Hydraulics. As mentioned previously, less attention is now given to the hydraulics of the rotary system of drilling. However, excellent work still is being done by some individuals and study committees within the API. The hydraulic system continues to be the key to success of the rotary system of drilling. A large amount of work remains to be done in evaluating the larger-size mud pumps which have become available during the past few years.

In drilling the softer formations, the design of the hydraulic system is very important. However, the hydraulic system may become of secondary importance as the formations become harder and the ability to generate cuttings decreases.

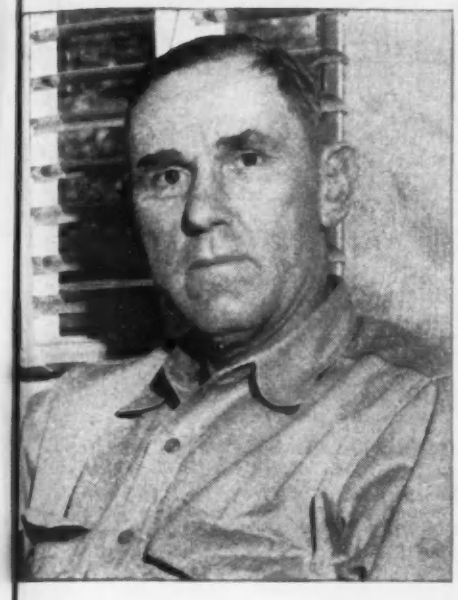
In a series of tests conducted in the Georgia B. King, No. 2, Deep Rock field, Andrews County, Texas, a uniform lime section was selected for test purpose from 6790 feet to 8220 feet. The bit size used was 8¾-inch and a bit weight of 60,000 pound was used. Alternate intervals of from 5 to 45 feet were drilled using a 650- and a 925-hp pump. The horsepower developed by the smaller pump averaged about 350 and by the larger pump about 600. The average drilling rate using 350 hp was 19.56 feet per hour as compared to 19.3 feet per hour using 650 hp.

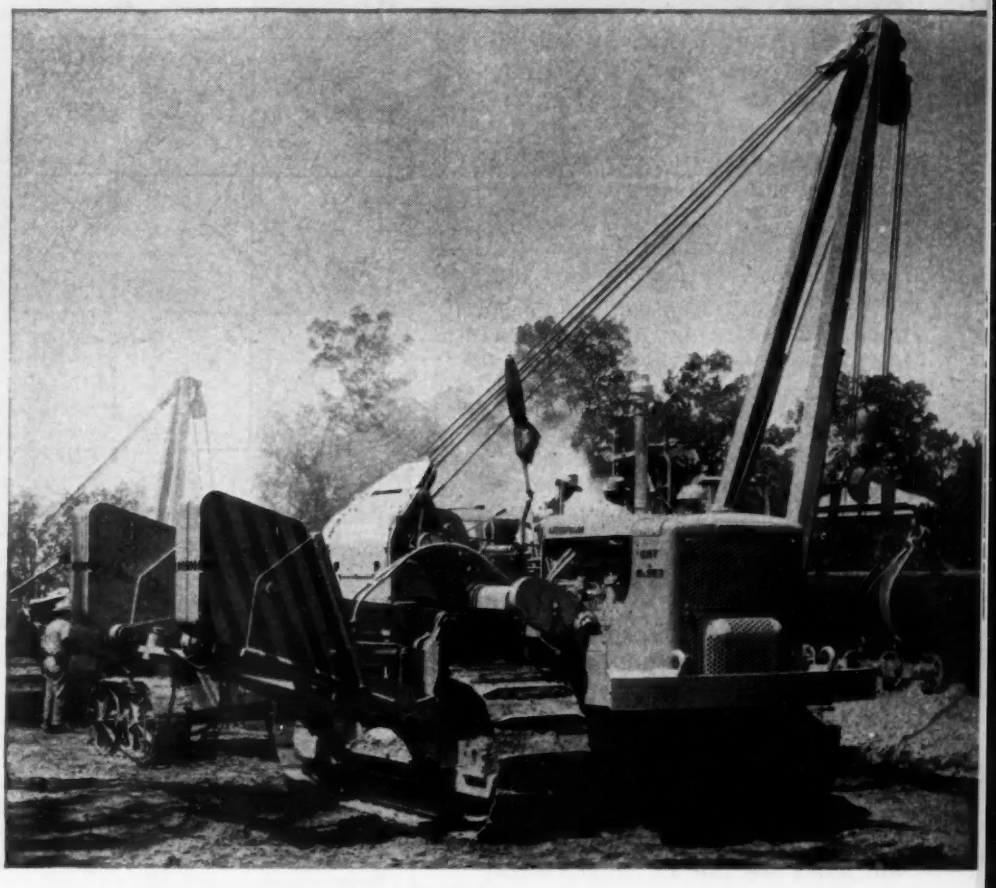
As formations become softer, however, horsepower plays an important part in drilling rate. As an example, in the Borregos field in Southwest Texas, the rate of penetration was increased from an over-all average of 28.7 feet per hour to 114 feet per hour by increasing the hydraulic horsepower input from 200 to 800.

On most power rigs it is the practice to operate at constant pump pressure. Figure 5 shows a calculation assuming 10,000 feet of 5-inch OD drill pipe, an 8⅝-inch hole and 2000-pound mud-pump pressure. Calculation for nozzle size and relative drilling rate have been made using water, a 10-pound per gallon mud, and a mud weighing 14.0-pound per gallon. It can be seen from these data that the relative drilling rate varies considerably with the nozzle size and amount of mud circulated as well as

"THE NEW NO. **583** IS THE ANSWER TO A PIPELAYER'S DREAM WHEN IT COMES TO CRADLING **BIG INCH**"

T. E. Davis, Superintendent
Williams Brothers Company





One of the first orders for the all-new CAT* No. 583 Pipelayer came from Williams Brothers Company, Tulsa, Oklahoma. A unit was put to work immediately in Virginia on a section of the 30-inch gas pipeline being built from Texas to New York for Transcontinental Gas Pipeline Corp. of Houston, Texas.

After watching the No. 583 at work beside other Caterpillar-built machines, Superintendent T. E. Davis commented:

"I've been 26 years with Williams Brothers in pipeline work using Caterpillar-built equipment. In my opinion, there is no better equipment made. And the new No. 583 is the answer to a pipelayer's dream when it comes to cradling big inch."

Mr. Davis particularly liked the ground clearance and counterweights on the new unit—the first pipelayer which is *all pipelayer and not a tractor attachment.*

The No. 583 has good stability and balance to obtain the best ground pressures on each track. In addition the counterweights retract well over track to give maximum right-of-way clearance. And they stay put in retracted position without hydraulic pressure.

The No. 583, *with a lifting capacity of 130,000 pounds,* is the most efficient pipelayer in history. Caterpillar engineers worked closely with pipeline people in designing it, so it answers the problems *you* wanted licked. No detail has been overlooked.

It has so many new developments, it must be seen personally to be appreciated. A few of these features are: the live drive which supplies steady power to the boom and load lines independent of the flywheel clutch, torque converter drive which permits crawl speeds necessary for lowering in, 21-inch ground clearance and others. So see the No. 583 soon. Your Caterpillar Dealer will show you how the *first unit-built* pipelayer can boost profits on your jobs.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR*

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MODERN HEAVY-DUTY PIPELAYING EQUIPMENT

the density of the liquid. In this particular example, the relative drilling rate was reduced from a maximum of 69 using water to a maximum of 37 using a 14-pound per gallon mud. This explains the reductions in drilling rate that are observed as the mud density is increased.

Bit Weight and Rotary Speed. Bit weight and rotary speed play a very important part in drilling rate. Unfortunately, we are unable to take full advantage of both of these factors. In actual operations there is always a compromise because of bit cost and the cost of making round trips. The large improvement in drilling rate cited in the opening paragraph is the result, not only of bit improvements, but also of a better understanding of the mechanism of obtaining the maximum footage from a bit at the fastest economical rate.

The effect of bit weight and rotary speed on drilling rate has been investigated in Humble's drilling research laboratory. In this laboratory, miniature bits are used to drill small samples, and formation conditions of temperature and pressure can be duplicated.

Auxiliary Equipment. In addition to the factors directly affecting the rate of penetration there are several items of auxiliary equipment which will affect the rate of drilling either in increased penetration rates or decreased trip time. Several types of feed controls are available which have been found to be satisfactory. A comparison of penetration rates on 7 wells before and 10 wells after the installation of a feed control on a Humble rig in West Texas showed a 10.6 percent increase in penetration rate on those wells drilled with the feed control.

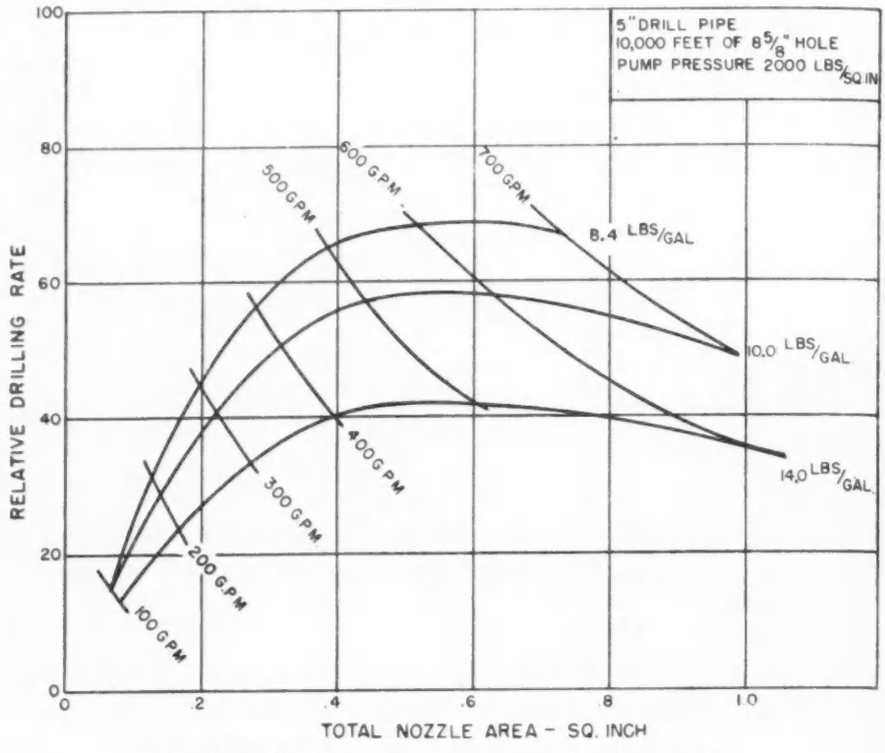


FIGURE 5—Effect of mud weight on relative drilling rate.

Air hoists in the derrick have been found to be a safe and efficient method for handling long strings of drill collars as well as reducing trip time. Also, the use of air hoists on the floor has proved to be a more efficient and safer method for handling drill pipe and casing than the cathead.

An item which is difficult to justify on a rig drilling shallow wells is power slips. However, on deep wells the use of power slips will reduce crew fatigue which will contribute to decreased trip time.

Hydraulic couplings, torque converters, air brakes, adjustable stabbing boards, and power tongs also contribute indirectly to increased drilling rates because of decreased fatigue of personnel and decreased rig downtime for repair.

Conclusions. The oil-drilling industry in the U. S. has steadily increased the rate of penetration over the past years by continuous improvements in operating techniques, materials, and equipment. A more widespread use and application of the factors which are known to produce increases in drilling rate should result in continuous improvements in rig performance in the future.

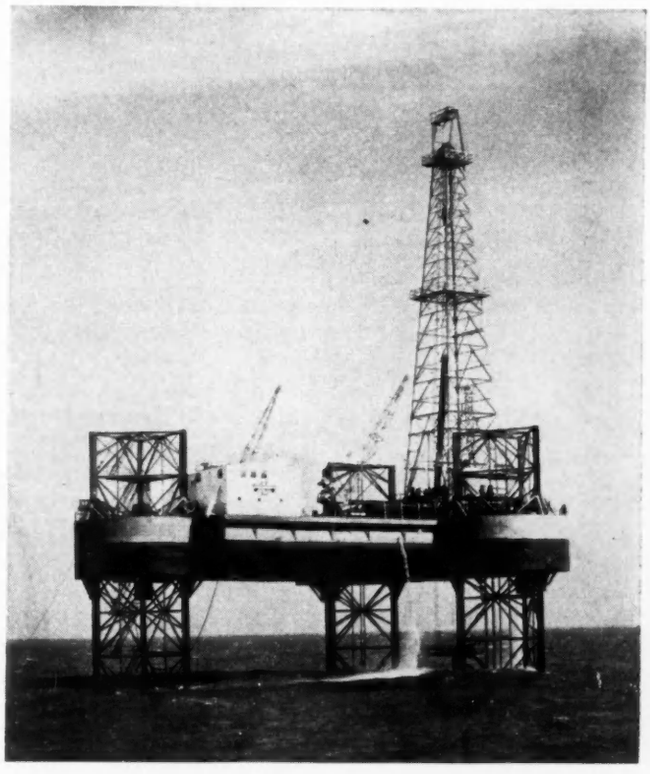
ACKNOWLEDGMENT

This article is abstracted from a paper entitled "Some Factors Contributing to Increased Drilling Rate" and presented at the API Southwestern District Meeting in Fort Worth, March 21-23, 1956.

The Golden Gulf Coast

Footage drilled along the Texas-Louisiana Gulf Coast in 1955 amounted to 14 percent of the U. S. total. The 1956 forecast predicts the drilling of 36 million feet in the area, or 16 percent of the national total. Average depth of the 3800 new Gulf Coast wells last year was 8350 feet . . . compared to U. S. average of 4075 feet. WORLD OIL's June issue will bring you up to date on developments in the area. There will be stories on deep well drilling . . . offshore drilling . . . and many others. Watch for the Gulf Coast Issue in June.

Left is the $3 million "Scorpion" of Zapata Offshore Company being outfitted at Galveston, Texas. Note the two 20-foot diameter tubes that are part of the flotation arrangement. The one on the left also houses the generating equipment and water tanks. The tube on the right houses the active mud tanks, mud lab, and cementing equipment.



Note the teeth of the rack on the corners of the legs that are used for raising and lowering. Photo at right shows the "Scorpion" on its first location near Aransas Pass. Location for the Standard Oil Company of Texas is in 46 feet of water and about 2½ miles from the beach.

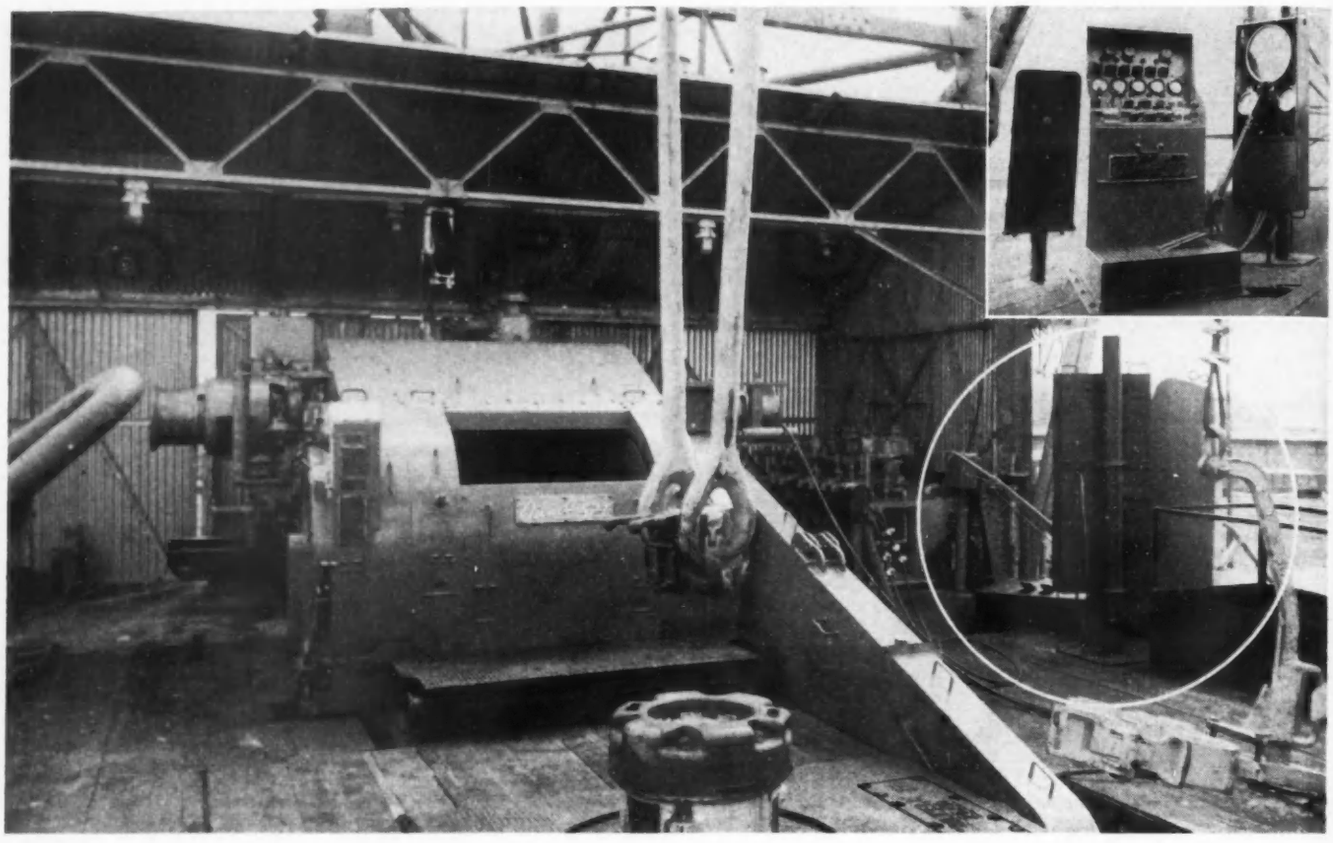
The Platform With Electric Legs

The unique three-legged Zapata drilling barge is on its first test—a test for oil . . . and a test of a radically different type of platform.

ZAPATA OFFSHORE COMPANY formally accepted the three-legged, 9 million-pound, self-contained drilling platform, "The Scorpion," at ceremonies in Galveston on March 20. This unit designed and built by R. G. LeTourneau, Inc., is the first three-legged mobile platform for use in offshore operations. The completely self-contained steel platform, costing approximately $3 million, was built at Natchez, Miss., and floated to Galveston where it was outfitted. There are many unique features on this drilling platform that make it a decided departure from the design of other platforms now operating, or under construction, for offshore drilling.

The Scorpion's 20 foot-deep body is a floating barge until it reaches location. There the legs are lowered to the ocean floor and the platform elevates itself to the desired height above the water. Physical dimensions are presented in Table 1. The spuds, located in wells outboard of the two sides and the aft end, are 140 feet high. They are open designed units, truss braced with tubular steel for stress loads, thus affording minimum resistance to wave action. The open design truss braced legs are of all-welded steel construction. A pontoon tank forms the lower end of each leg. Gear racks on the legs extend onto the pontoons to permit raising them into the spud wells during towing.

The three triangular shape spuds are raised by 63 electric motors. These



Drilling floor of the "Scorpion" showing the catworks, blowout preventer controls, and in the inset the drillers console for the operation of the drawworks that is mounted under the floor.

TABLE 1

Descriptive Data and Design Characteristics

GENERAL

Length of hull	150 ft.
Length, including end spud housing	185 ft.
Width of hull	80 ft.
Width, including side spud housings	150 ft.
Depth of hull	20 ft.
Draft fully loaded (approximately)	11 ft. 6 in.
Maximum height, platform deck to pontoon bottom	140 ft.
Displacement	4000 tons
Dead weight	2000 tons

Major Drilling Equipment

DRAWWORKS
- 1500 input hp
- 6 hoisting speeds
- 3 rotary speeds
- 2 reverse speeds
- 30 inch x 47 inch grooved drum
- 54 inch x 11 inch self-energizing brakes
- 60 inch hydromatic brake
- 45 inch dual high and lo drum clutches
- All drawworks clutches air controlled remotely

DRIVE
- 4-engine compound
- 28 inch dual master clutch
- 32 inch master compounding clutch (provides two easily separated units of two engines each)
- 32 inch pump clutches
- 1½ inch pitch quad compound chain
- 1½ inch pitch sextuple pump driving chain

ENGINES
- 4 twin diesel torque converter units
  - Rated 400 hp continuous torque converter—dumping type
  - 28 inch clutches to drive

PUMPS
- 2—8 inch x 18 inch pumps
  - Rated 925 input hp at 65 rpm
  - Displacement 930 gpm at 65 rpm

CATWORKS
- 350 input hp drawworks
- Drum for coring line operation
- Powered by twin diesel torque converter unit (identical to main engines)

DRILLING CONTROL
- Driven through hydromatic brake shaft to drumshaft
- Automatically controls bit weight through variations in dead line pull

BLOCKS
- Crown block 6—50-inch diameter sheaves for 1 ⅜-inch line rated 500 tons (special fast line sheave in derrick provides additional capacity)
- Traveling block 6—50-inch diameter sheaves for 1 ⅜-inch line rated 480 tons

SWIVEL
- Rated 400 tons

ROTARY
- Rated 350 tons

HOOK
- Rated 450 tons

DERRICK
- 140 foot x 30 foot base; 100 mile per hour actual wind load capacity, 1,100,000 pound capacity; 1,400,000 pound capacity substructure

ELECTRIC GENERATING EQUIPMENT
- 2 diesel engines direct connected to 2 200KW AC 440/.220 volt 1200 rpm electric machinery generators

motors are three phase gearmotors and are enclosed in water tight compartments in the spud housings. Twenty-one electric motors are required to raise each spud; seven to each corner of a leg.

The gearmotors, working through a final pinion gear, mesh with and operate the gear racks that are an integral part of the upright members that form the three corners for each of the triangular shaped legs. The 21 motors are synchronized, but operate independently to raise or lower one leg, six inches at a time. Each leg is raised separately.

It takes approximately one minute to raise the platform one foot. All motors have integral motor load brakes that set mechanically when the electric power is cut off and release electrically when power is applied. These gearmotors, mounted in the spud housing, are easily accessible through the watertight hatches on the deck.

Electrical power for operating the legs and elevating and lowering the platform is supplied by four diesel engine driven AC generators. These power units also furnish electrical power for operating the two 250-ton revolving cranes and the three elec-

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DIESEL-ELECTRIC DRILLING PLANT

drills deeper, faster, more economically than any other type of power or transmission

Completely self-contained, the ALCO diesel-electric drilling power package provides 100 per cent standby. No other power is required.

The basic ALCO unit provides 1370 hp for drawworks drive and 600 hp for two mud-pump drives, plus power for lighting and other auxiliaries. A wide variety of standard modifications allow for larger mud-pumps, rotary, mud-mix or coring-reel drives.

Flexibility and simplicity are prime reasons for the diesel-electric plant's economy. The driller has finger-tip control of smooth electric power for all operations, under any drilling condition. And the skid-mounted components can be moved readily from site to site.

This ALCO diesel-electric drilling power package is available at a cost comparable with that of an ordinary power rig. Contact your nearest ALCO representative or write P. O. Box 1065, Schenectady 1, N. Y., for a detailed brochure.

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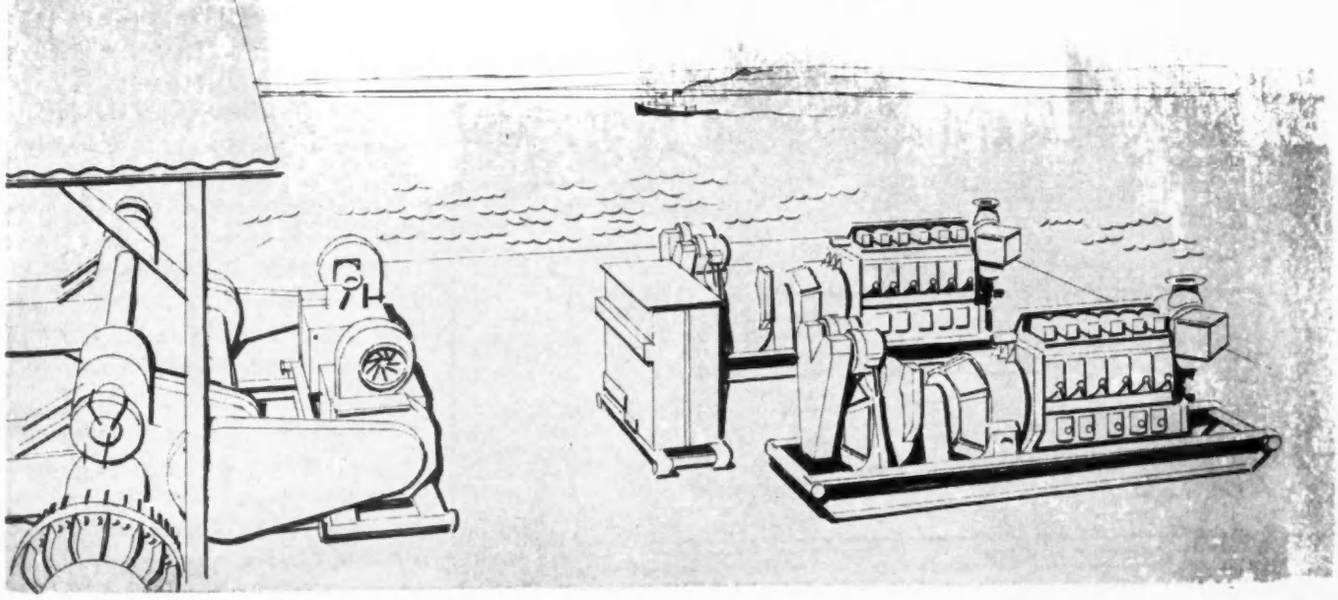
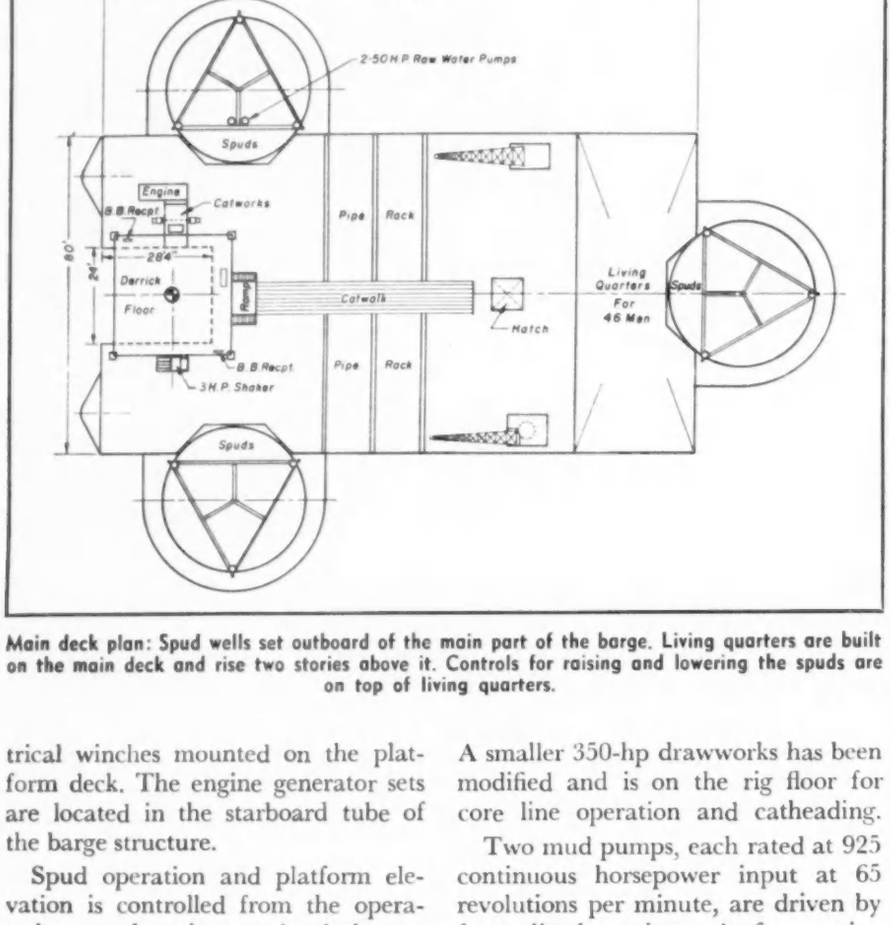




Main deck plan: Spud wells set outboard of the main part of the barge. Living quarters are built on the main deck and rise two stories above it. Controls for raising and lowering the spuds are on top of living quarters.

trical winches mounted on the platform deck. The engine generator sets are located in the starboard tube of the barge structure.

Spud operation and platform elevation is controlled from the operator's control station on the deck atop the crew quarters.

The 1500 horsepower drawworks is mounted below the drilling floor where it is protected from salt spray. A smaller 350-hp drawworks has been modified and is on the rig floor for core line operation and catheading.

Two mud pumps, each rated at 925 continuous horsepower input at 65 revolutions per minute, are driven by four diesel engines. A four-engine drive compound with a fifth shaft with a master compounding clutch has been installed. By disengaging the pumping clutches and engaging this master clutch, preparations to hoist are minimized and are controlled entirely from the drillers station.

The brake lever, from the drawworks below the floor, is a straight mechanical linkage that can be operated at the drillers console on the chain side of the catworks. The drillers console provides fingertip controls which enables a single man to operate the entire drilling rig.

All main drilling equipment is below deck protected from salt water spray. Only the catworks and pipe racks are on the main deck. The rig is provided with a 60-inch hydramatic brake and automatic drilling controls.

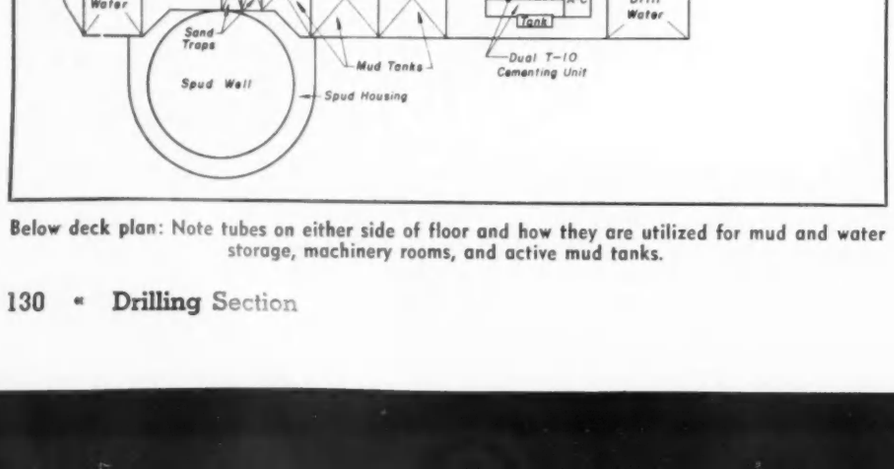
The barge structure is of tubular and corregated design to provide maximum structural strength and stability with minimum weight and internal bracing. Three large tubes, one on starboard, one on the port, and one on the aft end form the basic hull structure. These are joined by the center section which has a corrugated bottom design. Tubes and center sections are divided into compartments by bulkheads, decks, and water tight doors. Construction is of all-welded design.

Air-conditioned quarters for 46 men are located aft of the pipe rack and are built above the upper deck. The galley and recreation room are included in this two story housing.

A heliport can be installed, if required, on top of the aft spud. A stairway is already in place to provide access to and from the landing area.

The platform has a fully loaded draft of 11½ feet, can be towed in moderate seas, and located under most conditions of waves and pontoon bearing area.

The Scorpion left Galveston on March 22 and arrived at its first location on March 25. The location for the Standard Oil Company of Texas is in 46 feet of water and is approximately 2½ miles from the beach. Fifty-nine feet of conductor pipe was driven and on March 28 the well was spudded and 20-inch surface pipe was set. This test is slated to go to 10,500 feet. Besides testing subsurface strata for oil or gas this will also be a test for the sea worthiness and the adaptability of the Platform with Electric Legs to the rugged requirements of offshore drilling.—**The End**



Below deck plan: Note tubes on either side of floor and how they are utilized for mud and water storage, machinery rooms, and active mud tanks.

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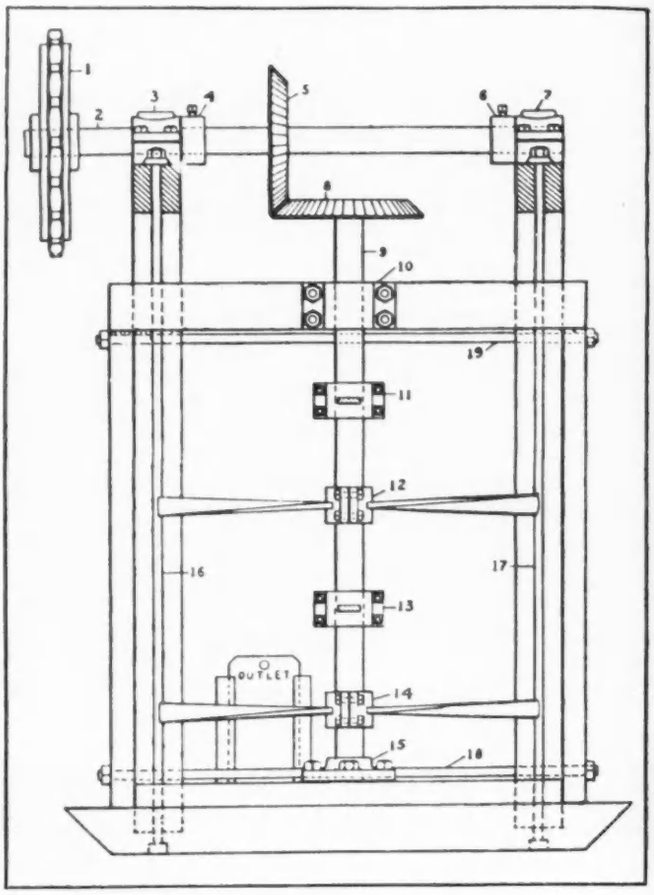
1886 Sweeney's rotary drill of 70 years ago had some features in common with rigs of today.



1910 This mud mixer used shortly after the turn of the century served same purpose as today's mixers.

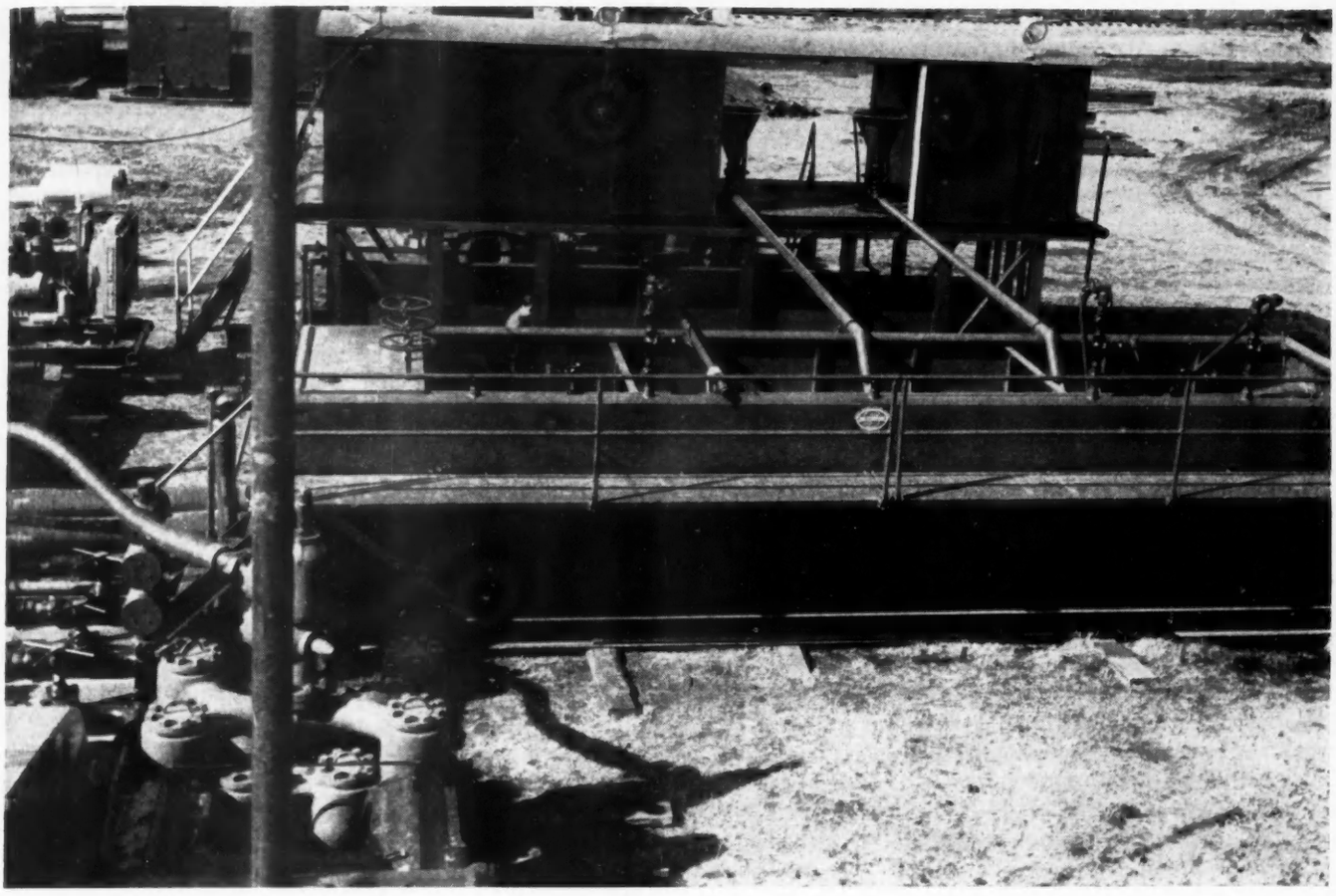
Whether it's muddy water, oil, or a complex chemical system . . .

It's Still Called Mud

For the 'weevil' or the 30-year veteran, here is an easy-to-understand explanation of the composition and application of drilling muds.

By DR. GEORGE R. GRAY
Baroid Division, National Lead Company, Houston

MUD TECHNOLOGY has developed along with the advances in drilling equipment and techniques. In 1845 a French engineer named Fauvelle used water pumped through a hollow boring rod to bring the drilled particles to the surface while drilling water wells. P. Sweeney in 1886 received a U. S. patent on a "stone drill" that displayed many features of today's rotary drilling rig, including the swivel head, rotary drive and roller bit. The role of mud as a sealing agent was recognized about that time.



1956 **Part of the mud system on a modern rotary rig.**

A U. S. patent application filed by M. T. Chapman in 1887 mentions the use of "a stream of water and a quantity of plastic material, whereby the core formed in the casing will be washed out and an impervious wall be formed along the outside." He suggested the use of clay, bran, grain, cement and similar materials. By 1906, a device for mixing surface clay, or gumbo, with water was available as auxiliary equipment for the rotary rig, but most mixing was done by the crew with shovels.

In the last 25 years, a host of substances have been proposed as additives for drilling mud. Over 300 U. S. patents have been issued on drilling fluids, covering entries in the dictionary of chemical products from Acacia gum to Zein. Price lists of suppliers of mud materials now list over two dozen products in the warehouse ready for delivery to the well site. The complexity and cost of a composition including such components seems to justify the title "drilling fluid," but at the well—*it's still called mud.*

Mud Has Many Jobs to Do. Today, as in the days of P. Sweeney's "stone drill," mud is used to remove cuttings from the hole. Although gas or air is used to carry the cuttings out of many wells, by far the greater number of wells are drilled with mud. Carrying capacity depends on viscosity and density of the mud and on the velocity of rise of the mud in the annulus between the wall of the hole and the drill pipe. Capacity of the pump is an important factor. Sometimes the viscosity of the mud must be kept high because the pump capacity is low.

A second important function of mud is to keep the fluids in the formation from entering the well. Blowouts, caused by uncontrolled flow of gas, oil, or salt water into the hole, are prevented by keeping the hydrostatic pressure of the mud column in excess of the fluid pressure in the formation. Not infrequently the hydrostatic head must be 1½ times that of water. In deep drilling, the density of the mud often is as high as 1.8 and sometimes is as high as 2.3.

Another job of the mud is to seal porous rocks so that mud is not lost into the formation. Loss of circulation occurs when the openings in the rock are large enough to allow the whole mud to enter. Particles of larger size are added to bridge the openings, or cement or other materials are introduced to solidify in the voids. If the openings in the rock are too small for the mud solids to enter, they filter out on the face of the rock, forming a cake, and only the liquid from the mud enters the pores. The permeability of this filter cake then determines the rate of loss of liquid from the mud. This liquid invades the formation and invasion of filtrate is an important factor in electrical logging. The amount and chemical content of the filtrate may influence the clean up of the completed well. Thick filter cake may cause sticking of tools and poor cement job.

Mud holds gravel and loose sand in place and prevents caving of shale. Good mud makes possible drilling with thousands of feet of open hole and effects a big saving in casing. Mud also cools the bit and lubricates the drill string.

Mud Composition Varies. Mud varies in composition from so-called "clear water" to emulsions containing a dozen commercial products, some dissolved and others suspended. Costs show a wide spread from only a few cents to over $20 a barrel. The liquid

phase of the mud may be water, oil or both. If both, the emulsion may be either oil-in-water or water-in-oil. By far the majority of wells are drilled with water-base-mud.

The composition of mud, like that of hash, depends partly on accident and partly on design. The water phase contains the soluble salts picked up from the formations drilled and the treating chemicals that have been added. The solid phase may be classified roughly into coarse and fine, or into enert and gel-forming fractions. By coarse is meant particles having an effective diameter greater than 0.5 micron and extending up into sizes that barely pass the mud screen. The coarse fraction consists of sand, limestone, shale and other materials from the formations drilled and finely ground barite which has been added to raise the density. Barite is the only heavy mineral commonly used to raise the density of mud. Hematite has been used as has galena and ferrophosphorus in rare instances.

Also included in the coarse fraction are the materials that may be added to stop loss of mud to porous formations. Among the materials used for this purpose are: mica, cane fiber, cottonseed hulls, saw dust, bark, cellophane, nut hulls, feathers, hog bristles, expanded perlite, and almost any other bulky fibrous, flaky, or granular material. These materials are not added unless needed to maintain circulation of mud through the hole.

The fine fraction of the solids consists principally of clays. Early practice was to make mud with clay from any convenient source but the superiority of bentonite was soon recognized. Now over half a million tons of bentonite are used annually.

The properties of Wyoming bentonite that make it particularly useful in mud as a thickening and sealing agent have been related to the colloid chemical behavior of the principal constituent, the clay mineral montmorillonite. A greatly magnified particle of montmorillonite might be likened to a pad of paper. When the particle is placed in fresh water, the water enters between the sheets and separates them. The surfaces of the sheets hold the water tightly and the water held may amount to several times the volume of the clay. Negative charges on the surface of the sheets exert repulsive forces which tend to hold the sheets apart. Both positive and negative charges occur on the broken edges of the sheets.

In the presence of small amounts of an electrolyte (such as salt, or lime) the repulsive forces are lessened and the sheets form aggregates unless stirring keeps them apart. If the clay concentration is high enough, all of the water is held within a gel structure that develops when the suspension stands undisturbed. At high concentrations of electrolyte, less water is held by the clay sheets; the aggregates are more compressed, and several aggregates may clump together, like several pads of paper stuck together.

These particles tend to settle more rapidly than the smaller ones formed in fresh water. In this flocculated condition, a far higher concentration of bentonite is required to produce a stable mud than in fresh water.

Bentonite is not an effective thickening and sealing agent in salt water. When rock salt is drilled, or when a mud is made with salt water, a different sort of clay, attapulgite, is used instead of bentonite. Attapulgite has a fibrous structure. It can be dispsersed in salt water and is adequate as a suspending agent but does not reduce filtration like bentonite does in fresh water.

Filtration properties of mud are improved (i.e., filtration of water from the mud is decreased) by adding colloidal materials which plug the pores in the filter cake. A great many organic products have been tried, including the natural gums, starches and mucilagenous materials, and several synthetic polymers. The products most commonly used are pregelatinized corn starch and sodium carboxymethylcellulose (CMC).

Frequently the mud needs "thinning" rather than "thickening." An improvement in sealing-off properties or an increase in density may be desired without a rise in viscosity. Use then is made of "thinners" or dispersants that act to oppose the development of gel structure in the mud. The thinners in common use are natural tannins, the humic acid or lignitic products, and the lignosulfonates. The natural tannins include the extracts or ground bark of several trees, such as, quebracho, chestnut, hemlock, and mangrove. The tannins often are used along with caustic soda. The polyphosphates, such as sodium tetraphosphate and sodium acid pyrophosphate, are particularly effective in reducing gel formation.

Flocculants, as well as dispersants, are added to mud. Calcium sulfate, as gypsum plaster, is added in preparing "gyp mud" used in some areas to drill anhydrite and salt beds. Lime is used to flocculate clay and thicken the mud in shallow drilling of loose gravel and sand, and along with caustic soda and tannins in the "lime muds" to be discussed later.

Emulsion muds have come into wide use in recent years. Oil is emulsified in water or any water-base mud by an emulsifying agent which serves to prevent the coalescence of the oil droplets. Emulsifying agents include soaps, humic acid compounds, lignosulfonates, various surfactants, starch, CMC, and finely divided solids. The principal advantages in use of emulsion muds are: an increase in drilling rate, decrease filtration, improved hole condition, increased bit life and decreased torque. These all contribute to faster completion of the hole.

Graphite is sometimes added to mud to reduce friction between the drill string and the walls of the hole. Finely ground walnut hulls are also used to decrease torque.

Emulsions of water in oil can be made by dispersing water into oil or an oil-base mud containing a suitable emulsifying agent, such as a calcium soap. Water-in-oil emulsion muds resemble oil-base muds but are less expensive.

Oil-base muds are not used extensively but find application in coring for determination of water content of the reservoir rock; for drilling producing formations that contain clayey materials that, on contact with water, reduce the permeability of the formation to oil. Oil-base muds generally depend on various soaps to provide suspending properties and on asphalt for sealing. Sometimes finely ground oyster shell is used to raise the density.

Drilled Materials Affect the Mud. Thus far, mention has been made only of materials that are added to the mud deliberately. The need for adding many of these materials develops because of the presence of other materials inadvertently incorpo-

rated into the mud. For example, as shale is drilled and becomes dispersed in the mud, thinners are added to counteract the effect of the shale. Some "contaminants" which may have very objectionable effects on mud properties are met in normal drilling. The principal ones are cement, anhydrite and salt.

Contamination of the mud by cement usually occurs first when casing is set. The action of cement on a clay-water mud is like that of lime—the clay is flocculated and there is an increase in gel rate, gel strength and filtration. Treatment consists in adding substances which remove the flocculating calcium ion, redisperse the clay aggregates and reduce the pH. Chemicals commonly used for that purpose are sodium bicarbonate, sodium acidpyrophosphate, and tannins.

Anhydrite (calcium sulfate) gets into the mud in drilling beds of anhydrite, or veins of anhydrite in shales or limestone The calcium sulfate is soluble enough to cause flocculation of clay in fresh water muds. Thickening occurs first and finally thinning and settling of solids. Filtration increases as flocculation progresses. Treatment to counteract anhydrite depends on the type of mud in use and the amount of anhydrite to be drilled. Soda ash is adequate for small contamination but the sodium sulfate formed in the reaction becomes objectionable in drilling thick sections of anhydrite. Barium carbonate removes calcium sulfate leaving no soluble byproduct. Lime-treated muds are not affected by anhydrite.

Lime-treated muds, sometimes called "lime-base" or "calcium-base" muds, have been used extensively in recent years and they have found particular application in the deep wells drilled along the Gulf Coast. Lime-treated muds are much less affected by contaminants than are the usual fresh-water muds. Cement and anhydrite have little or no effect. Instrusion of salt water in amounts that would cause a fresh-water mud to take on the consistency of putty may not seriously thicken a lime-treated mud. Another advantage of lime-treated mud is low gel strength, which is important in reducing swabbing and spudding pressures when the pipe is moved up and down in the hole.

The calcium ion represses the dispersion of shale cuttings, with the result that less dilution with water and less reweighting with barite is necessary to control the flow properties of heavy muds. Lime-treated muds usually contain from 2 to 4 pounds of organic dispersant (lignitic material, calcium lignosulfonate or quebracho), 1 to 3 pounds of caustic soda and 2 to 8 pounds of lime per barrel of mud. Often pregelatinized starch or CMC is added to reduce filtration.

Salt enters the mud when sands carrying salt water under pressure greater than that of the mud column are drilled, and when rock salt in beds or domes is penetrated. The immediate effect of salt on a fresh-water mud is to cause an increase in gel rate, viscosity and filtration. As flocculation of the clay proceeds, the viscosity may decrease while filtration increases further. Salt cannot be removed by chemical treatment but concentrations up to roughly 50,000 parts per million can be tolerated by heavy treatment with organic dispersants and alkalies. Filtration is controlled with starch, CMC, or other organic colloids. Drilling of rock salt requires the preparation of a mud saturated with salt to prevent dissolving a cavity in the salt bed. Thick sections of salt can be drilled with saturated salt water thickened by attapulgite clay. If shale or sand formations are exposed, organic filtration-reducing agents must be added to avoid sticking the drill string.

Mud Program Requires Planning. Many factors in addition to those directly related to the formations to be drilled must be considered in planning a mud program. The drilling equipment is important. Mention has been made of the pumps in relation to mud performance in carrying cuttings from the hole. Arrangement of pits, screens for removal of cuttings, mixing equipment, and facilities for handling and storing mud and mud materials—all affect the efficiency and economy of the mud program. De-sanders, de-gassers, and centrifuges aid in keeping the mud in good condition.

Water supply for the mud must be considered both in regard to quantity and quality. In some areas most of the cost of treating the mud is actually chargeable to the make-up water. Water is sometimes expensive or hard to get and money can be saved by treating the mud to reduce consumption of water.

Mud properties affect the drilling rate in clearance of cuttings and in application of pressure to the rock. Total time spent in drilling to the desired depth is determined by the necessity for keeping the drilled hole open. Hole enlargement from washouts and caving, or from dissolution of salt, demands special attention to mud properties. Drilling practices affect the mud program—for example, too rapid withdrawal of the pipe may cause swabbing and lead to the use of higher weight mud than is actually necessary.

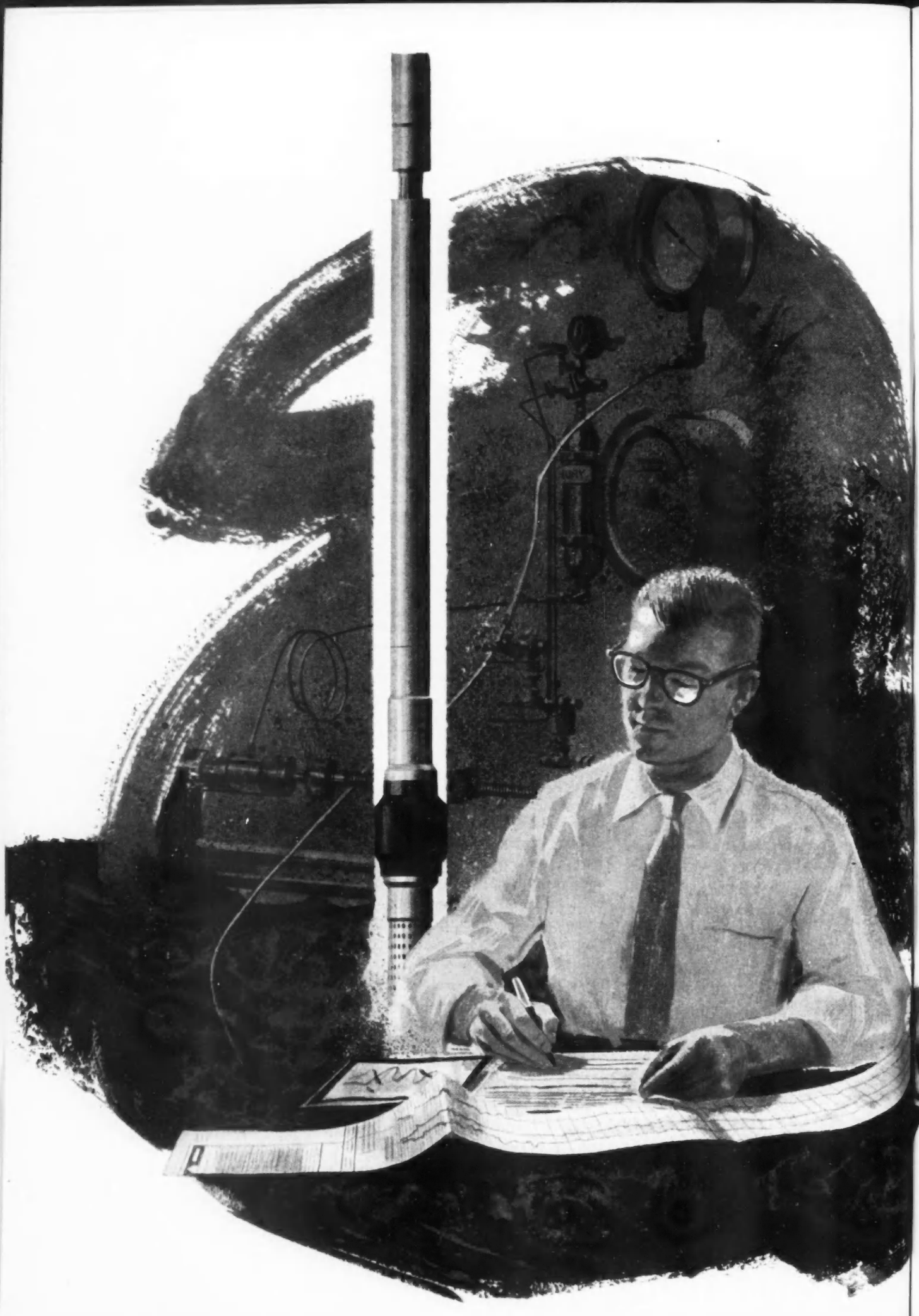
Information gained by the various methods of logging may be affected by the mud used. Logging includes examination of cuttings and cores, mud analysis, and electrical logging. The information to be sought and the methods to be used should be considered in planning the mud program.

The primary objective in drilling a well is to test and complete it successfully. Mud properties are of concern in running testing tools in the hole, making tests, landing casing, cementing, and perforating. Production from the well may be affected by the invasion of the producing formation by mud, or filtrate, and by the reaction of the filtrate with constituents of the formation. All of these factors relating to completion should be considered in planning the mud program.

Usually the first question asked about a mud program is, "How much does it cost?" The cost to consider is the over-all cost of drilling, logging, testing, and completing the well in such way as to provide the information wanted and the greatest possible production. Spending for mud materials should be balanced against possible savings in rig time and gains in production.

The drilling fluid plays a significant part in the success of drilling, logging, testing, and completing the well. Mud affects and is affected by the formations drilled and the materials added. A great variety of substances, some naturally occurring and some synthesized for a special application, find use in drilling mud. However simple or complex the composition, from slightly dirty water to an elaborate concoction of specialty products—*it's still called mud.*

—**The End**



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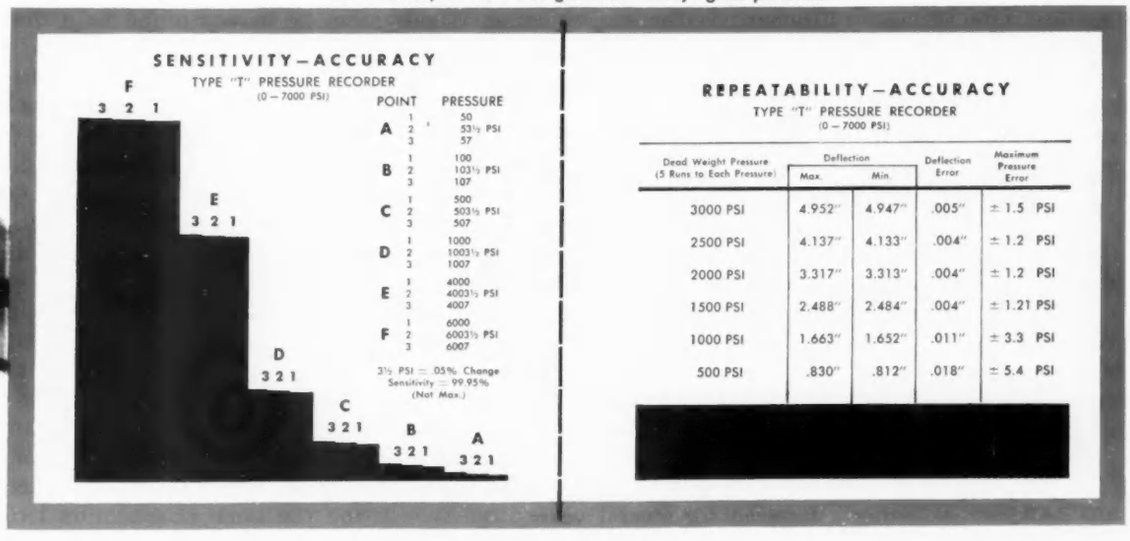
SENSITIVITY—ACCURACY
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(0 — 7000 PSI)
POINT
PRESSURE
A 1 50 2 53½ PSI 3 57
B 1 100 2 103½ PSI 3 107
C 1 500 2 503½ PSI 3 507
D 1 1000 2 1003½ PSI 3 1007
E 1 4000 2 4003½ PSI 3 4007
F 1 6000 2 6003½ PSI 3 6007
3½ PSI = .05% Change
Sensitivity = 99.95%
(Not Max.)
F 3 2 1
E 3 2 1
D 3 2 1
C 3 2 1
B 3 2 1
A 3 2 1
REPEATABILITY—ACCURACY
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Deflection Min.
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Now Tables for Woods-Lubinski Data

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When field personnel was hesitant to use the graphical data on crooked hole problems, the API Study Committee compiled the material in tabular form in the hope of gaining wider acceptance.

About the Author

H. M. ROLLINS received a B.S. degree in mechanical engineering from Texas A&M in 1942 and, after service in the Air Force, joined Hughes Tool Company in 1947. After serving as assistant product engineer for tool joints and drill collars, he joined the Drill Collar Service Company as chief engineer in 1951. He continued in that position when the company was reorganized in 1953 as Drilco Oil Tools, Inc.

By H. M. ROLLINS
Drilco Oil Tools, Inc.
Midland, Texas

A RELUCTANCE on the part of field personnel to use the Woods-Lubinski data in graphical form has prompted the API Southwestern District Study Committee on Straight Hole Drilling to prepare numerical tabulations of representative conditions taken from these charts.

Factors affecting straight hole drilling were investigated mathematically by H. B. Woods and Arthur Lubinski[1, 2, 3, 4, 5] and presented in graphical form in 1954. This graph illustrated the relationship between hole size, drill collar size, hole inclination, formation dip, and weight on the bit. With this chart it was possible to compare in numerical values an existing condition in the hole with what might result if any one or more of these factors was changed. With increasing use of stabilizing tools in the drill stem a further study was made and in March, 1955, Woods and Lubinski published a paper demonstrating the effectiveness of the use of stabilizers and the proper placement of those stabilizers.

Unfortunately, the people who need this information most, the people who are actually operating the drilling rigs, have not made extensive use of this information because of their reluctance to use graphical solutions. At the suggestion of Woods and Lubinski, the API Study Committee has prepared numerical tabulations of representative conditions taken from these charts. They have prepared tables for formation dips of 7½, 15, and 30 degrees. At each dip condition tables are included for hole inclinations of 2, 3, 4, 6 and where applicable 10, 15 and 20 degrees. These values are prepared for all practical drill collar sizes by one-half inch increments for 6½, 6¾, 7⅞, 8¾, 9, 9⅞, 10⅝, and 12¼ inch hole sizes. Variations in bit weights have been used from a very small value up to the maximum values which can be foreseen for several years.

It must be made clear that use of this information must be based on an equilibrium condition; that is, the hole angle must remain constant for an interval of 60 to 100 feet at a constant weight on the bit. Also, it should be pointed out that use of a reamer at the bit makes these data invalid.

Figure 7 is an example taken from these tabulations. Use of the tables can be demonstrated by a discussion of several practical examples.

The general procedure is to locate in the tables a set of conditions known to exist in the formation to be drilled; that is, to find in the tables the weight that has been carried at a certain angle in a given hole size with a certain drill collar size. This point will be found in the tables on a horizontal line bearing a letter of the alphabet. This letter classifies the formation as extremely crooked (line D) or mildly crooked (line N). To find the weight that may be carried in the same formation under some new condition, we locate that weight on a line bearing the same classification letter under the new hole size, collar size, and hole angle desired. Use of stabilizers

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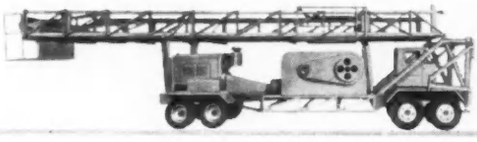

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8-3/4" HOLE SIZE - 15° FORMATION DIP

DRILL COLLAR SIZES

HOLE ANGLE AND CLASS	6"	6" with Stabilizer at Height Shown		6½"	6½" with Stabilizer at Height Shown		7"	7" with Stabilizer at Height Shown	
2° 2D									
2E	3100	3800	93-103	3500	4300	80-100	4000	4900	89-91
2F	4200	5300	70-47	4800	6000	88-97	5500	6900	87-96
2G	5200	6600	87-96	6000	7600	86-95	6700	8800	86-95
2H	7500	9600	84-93	9000	11500	84-93	10200	13000	84-93
2I	10000	13000	81-90	12000	15500	81-90	14200	13000	81-90
2J	12000	16000	74-87	15000	20000	79-87	19000	24000	79-87
2K	15000	21000	72-80	18000	25000	77-85	22000	30000	76-84
2L	18500	30000	60-66	24000	36000	63-70	30000	45000	66-73
2M	23000	41000	50-55	30000	54000	52-59	39000	70000	53-58
2N	26000	47000	46-51	36000	65000	45-50	48000	86000	48-53
3° 3D	3000	3750	81-90	3500	4400	81-89	4000	4350	79-87
3E	4500	5700	80-88	5100	6400	80-88	6000	7600	78-86
3F	5800	7400	79-87	6900	8900	79-87	8000	10000	79-85
3G	7000	9000	78-86	8500	11000	77-85	10000	12700	76-84
3H	10000	13000	74-82	10500	13500	76-84	15000	19000	74-82
3I	13500	18000	72-79	17000	28000	71-80	20000	26000	72-79
3J	18000	26000	65-72	20000	27500	70-77	25000	35000	69-76
3K	19000	28000	60-66	21000	35000	65-72	30000	41000	67-74
3L	23000	39000	51-56	31000	50000	54-60	40000	61000	56-62
3M	28000	50000	45-50	37000	67000	44-48	50000	90000	47-52
3N	32000	58000	41-45	45000	81000	36-40	60000	108000	41-45
4° 4D	4000	5000	75-83	4800	6000	74-82	5000	6300	74-82
4E	5800	7400	74-82	7000	8900	73-81	8000	10000	72-80
4F	7500	9600	72-80	9000	11500	72-80	10500	13000	72-79
4G	9500	12000	71-78	11500	14700	71-78	13000	16500	71-78
4H						69-76	18000	23500	68-76
4I						65-72	27000	36500	65-72
4J	21000					61-67	32000	44000	63-70
4K						57-63	39000	56000	59-65
4L						46-51	50000	80000	49-54
4M	33000	60000	42-44	45000	81000	36-40	61000	110000	41-45
4N	38000	68000	38-42	53000	- -	- -	71000	- -	- -
6° 6D	6000	7600	67-74	7200	9000	67-74	8200	10000	66-73
6E	8700	11000	66-73	10000	13000	65-72	12000	15000	65-72
6F	12000	16000	63-70	14500	19000	64-71	17000	21000	63-70
6G	14500	19000	62-68	18000	24000	62-68	20500	26000	62-68
6H	19500	26000	60-66	24500	33000	61-67	29000	39000	60-66
6I	25000	36000	54-59	32000	45000	57-63	39000	54000	57-63
6J	29000	45000	47-52	37000	55000	50-55	46000	65000	53-61
6K	33000	59000	42-46	44000	70000	43-47	56000	82000	48-53
6L	38000	68000	38-42	49000	33000	36-40	67000	- -	- -
6M	43000	- -	- -	58000	- -	- -	79000	- -	- -
6N	47000	- -	- -	65000	- -	- -	90000	- -	- -

8-3/4" HOLE SIZE - 15° FORMATION DIP

DRILL COLLAR SIZES

HOLE ANGLE AND CLASS	7½"	7½" with Stabilizer at Height Shown		8"	8" with Stabilizer at Height Shown	
2° 2D						
2E	4500	5600	84-93	5000	6200	76-84
2F	6100	7600	83-96	6500	8200	76-84
2G	7700	9700	83-92	8100	10000	75-83
2H	11500	15000	80-88	13000	16500	74-82
2I	16000	20500	78-86	18000	23000	72-80
2J	21000	27000	77-85	24000	31000	71-78
2K	27000	37000	74-86	31000	41000	70-77
2L	37000	52000	70-77	45000	62000	67-74
2M	50000	80000	57-63	68000	102000	56-62
2N	68000	122000	46-50	95000	170000	34-38
3° 3D	4500	5600	75-83	4300	6000	59-76
3E	6500	8100	75-83	6800	8500	69-76
3F	8500	10700	74-82	9000	11000	68-75
3G	11000	14000	74-82	11500	14500	67-74
3H	16500	21000	72-79	18000	23000	66-73
3I	23000	30000	70-77	26000	33000	65-72
3J	29000	38000	68-75	33000	42500	63-70
3K	37000	50000	66-73	44000	59000	62-68
3L	50000	72000	60-66	62000	86000	59-65
3M	67000	114000	48-52	89000	134000	45-50
3N	85000	- -	- -	125000	- -	- -
4° 4D	5800	7250	70-77	6200	7750	64-71
4E	8500	10700	70-77	9000	11300	63-70
4F	11500	14500	64-76	12000	15000	63-70
4G	15000	19000	68-75	16000	20000	63-69
4H						
4I						
4J				45000	60000	58-64
4K						
4L						
4M	80000	- -	- -	110000	- -	- -
4N	110000	- -	- -	160000	- -	- -
6° 6D	9000	11000	63-70	9500	12000	57-63
6E	13000	16600	62-68	14000	18000	57-63
6F	19000	24000	61-67	20500	26000	56-62
6G	24000	31000	60-66	26000	33500	56-62
6H	34000	45000	58-64	38000	49000	54-60
6I	47000	64000	56-62	55000	73000	53-58
6J	57000	78000	54-60	67000	90000	52-57
6K	70000	100000	51-56	87000	123000	49-54
6L	85000	130000	44-48	115000	- -	- -
6M	110000	- -	- -	155000	- -	- -
6N	125000	- -	- -	190000	- -	- -

FIGURE 1—This is an example of the tabulated data compiled by the API Study Committee. The example explained in the text is blocked in.

and best position for stabilizers are also considered in the tables.

For cases in which no change in hole angle is to be considered, the formation dip is not needed. The same answer would be obtained on any of the formation dip tabulations.

As an example, in Figure 1, we have for a known condition an 8¾-inch hole, 6-inch drill collars, with 4° hole deviation maintained at 21,000 pounds. In the 15° dip tables this point is found at Line 4J. We wish to know what weight could be carried at this same angle in this formation if 8-inch collars were used. On line 4J under 8-inch collars, the weight that can be used is 45,000 pounds. With a stabilizer placed at 58 to 64 feet, 60,000 pounds could be used, while maintaining 4°.

If we wish to know the weight that could be carried at 4° in some other hole size while drilling this same formation, we can find these values on line 4J under the appropriate hole size and collar size in the same 15° dip table. For example in 6¾-inch hole with 5-inch collars, 13,500 pounds could be carried; in 7⅞-inch hole with 7-inch collars, 31,000 pounds; in 12¼-inch hole with 8-inch collars, 44,000 pounds. Note that we have emphasized that the hole angle must be the same and values must be taken in the same dip tables; however, for this type problem where hole angle does not change, any of the dip tables could be used.

Complete sets of these tabulations for 7½, 15, and 30-degree formation dips can be obtained from Drilco Oil Tools, Inc., Box 1651, Midland, Texas.

For cases where hole angle is to change, or formation dip changes, the formation dip must be known. To illustrate this, let us use the same known conditions as above, 8¾-inch hole, 6-inch collars, 4° deviation, and 21,000 pounds. Let us find the weight that can be used at 6° deviation with 7-inch collars in 7⅞-inch hole, in this same formation.

Dip	Classification of Known Conditions	Usable Weight for 6° 7" Collars, 7⅞" Hole
7½°	4G - 4R	6G - 6H - 70,000 lbs.
15°	4J	6J 47,000 lbs.
30°	4K - 4L	6K - 6L - 40,000 lbs.

Note that if the dip were assumed to be 7½ degrees and was actually 30°, a serious error in usable weight would result.

A recent paper by Lubinski and Blenkarn illustrates this point in more detail. These authors have recommended that dipmeter surveys be made specifically for the purpose of choosing the best techniques in combatting crooked hole problems.

An examination of some values taken from these tabulations illustrates the usefulness of the Woods and Lubinski information not only for solving specific problems on a given hole but for determining general information which may give a better understanding of the straight hole drilling problem. Figure 2 is an illustration of the values taken from the 15-degree dip tabulation, comparing the weight on the bit expressed in pounds per inch of bit diameter against the variation in hole size. One set of curves is for a moderate crooked hole situation as expressed in values of the tabulation taken from line H. The other is for a severe crooked hole

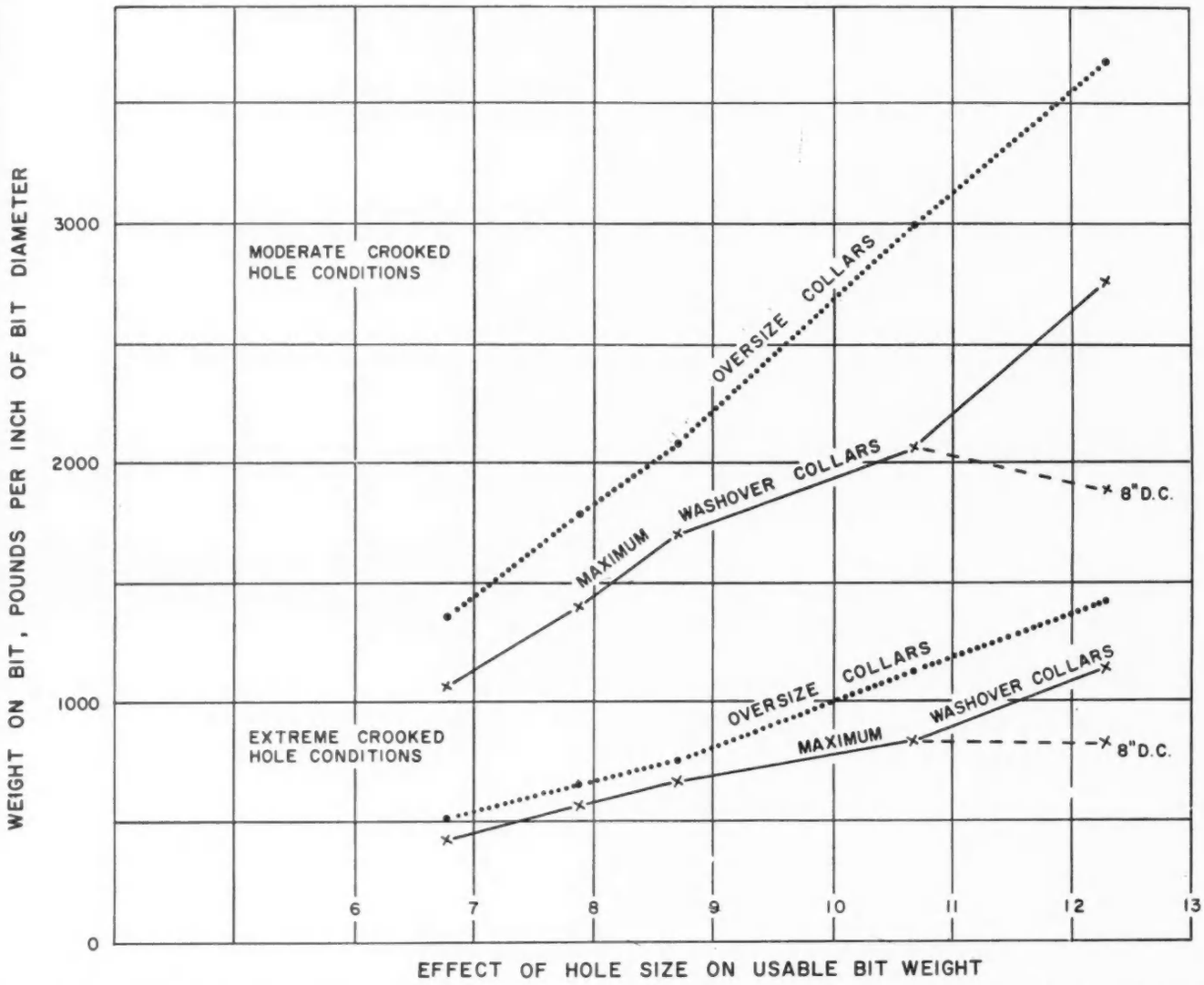

FIGURE 2—A comparison in the drilling weight per inch of bit diameter with the variation in well bore diameter in severe and moderate crooked holes.

condition, taken near the top of the tables under line E. In each set, one curve is plotted for the weight which may be carried on the largest drill collar size which may be washed over by conventional West Texas practice. The other curve is for the maximum drill collar size which is being run in this hole size without regard to wash over problems. You will notice that in moderate crooked hole situations, a great deal more weight per inch of bit diameter may be run in large diameter holes than in small diameter holes. This difference is not so pronounced, however, under severe crooked hole conditions. The 8-inch collar is shown in the 12¼-inch hole size since this is the most popular collar size for this hole size.

The term "pounds per inch of bit diameter" is used because this factor is related to drilling rate in feet per hour, regardless of hole size. Drilling rate increases directly as the weight on the bit in terms of lbs. per inch of bit diameter, while the stiffness of the drill collar increases as the 4th power of the diameter of the drill collar and the weight of the drill collar increases as the square of the diameter of the drill collar. Therefore, in a larger hole a much heavier and much stiffer bottom hole assembly is possible than in the small diameter holes.

Conference for Drilling Executives Set

The American Association of Oilwell Drilling Contractors will sponsor a 3-day conference for drilling executives in Dallas May 9-11. For more information, turn to What's Happening Among Industry Associations in this issue.

ACKNOWLEDGMENT

This is an excerpt taken from the paper "Studies of Straight Hole Drilling Practices—1952 to 1956" presented as a Summary Report of the API Southwestern District Study Committee on Straight-hole Drilling, in Fort Worth, Texas, March 21-23, 1956.

The original suggestion for presenting the Woods and Lubinski data in tabular form was made by B. E. Groenewold, Exploration Drilling Company. Groenewold, chairman of the AAODC Committee concerned with publication of the Toolpushers Manual, suggested that such a tabulation be made for inclusion in the manual.

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[2] Arthur Lubinski, Research Department, Stanolind Oil & Gas Company, Tulsa.

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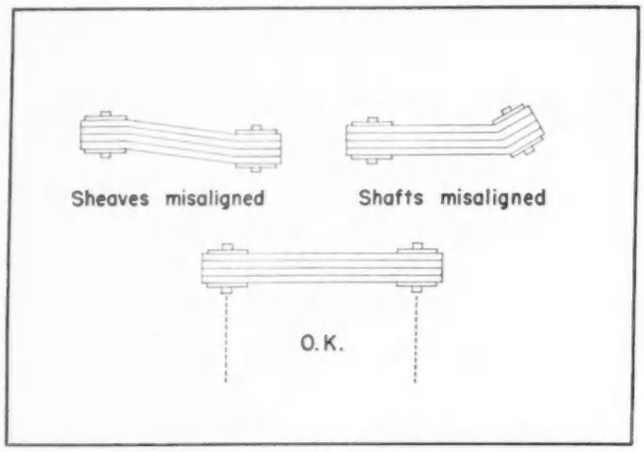
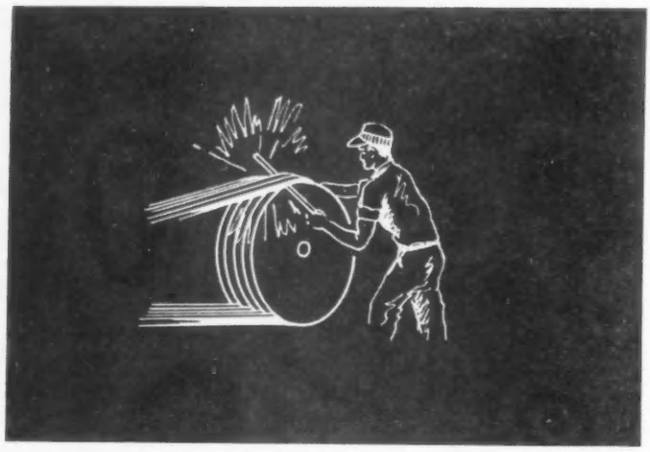
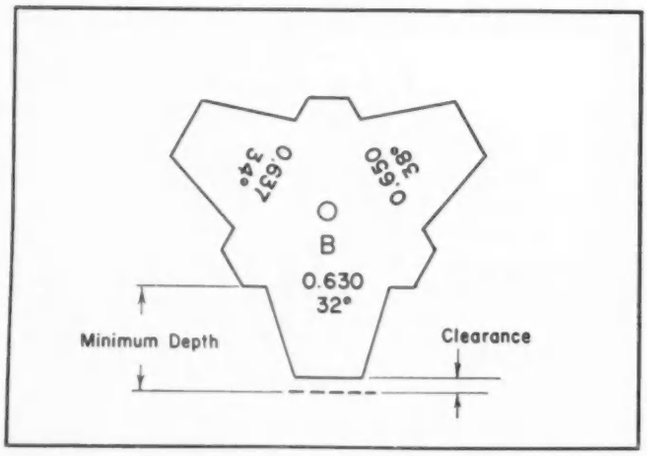


WATCH THIS Here are two common faults that contribute to short life and poor service from V-belt drives. Make certain that the sheaves are lined up properly and that shafts are reasonably parallel. Of these two suggestions, keeping shafts parallel is more important.



DON'T DO THIS Never pry belts over a sheave. Instead, loosen the take-up. V-belts are elastic but they are not rubber bands. Forcing a belt over the groove can break the tensile cords in the belt making it impossible for belt to carry its share of the load.



THIS WILL HELP A simple template well marked will enable the operator to check the wear on the sheaves quickly and accurately. Wear is observed by seating template squarely in the groove and sighting between the sides of the template and sides of groove.

How to Install and Maintain V-Belts

It appears quite simple, but here are a few basic procedures that will lengthen belt life and increase drive efficiency.

By W. S. WORLEY
The Gates Rubber Company, Denver

MOST RIGS today use V-belt drives to transmit power from the prime movers to the pumps. Characteristically, a V-belt drive requires surprisingly little care and maintenance. An understanding of the fundamentals of how a V-belt operates in the sheave groove, and a knowledge of the stresses to which its various components are subjected while transmitting power, enables an operator to: (1) Identify and correct the troubles which infrequently arise, and (2) realize long, trouble-free service for which the drive was designed.

SETTING UP THE DRIVE

Use a matched set of belts of the same manufacture. Of primary importance to optimum performance and long belt life is use of a matched set of belts of the same manufacture. Do not try to make up a set of belts of different manufacture or of some new and some old belts. A new belt, when placed on a drive with old belts that are worn, may take more than its share of the load. It will be shorter and probably will ride higher in the grooves.

If belts of different manufacture are used, there is a good chance that pitch line locations will not be the same for each belt. Differential driving will result. Possibly the strain constants of the belts may be different. This will result in different amounts of creep and, again, in differential driving.

Clean the sheaves. Clean oil and grease from the sheaves. Remove rust and burrs. Since the belts operate by friction, anything which tends to reduce the coefficient of friction between the belts and the sheaves can mean that higher belt tension are required to handle the load.

The V-belt wedging effect multiplies the normal force produced by belt tension to the point that belt dressings are not required on V-belt drives. In fact, such dressings can do more harm than good. Some dressings tend to break down the rubber in the V-belts, and also to pick up dirt and sand to which pump drives are exposed. As the belt moves with respect to the sheaves, the sand acts as an excellent lapping compound which quickly wears down the groove sidewalls.

Align the drive. Make sure that the sheaves are lined up properly and that shafts are reasonably parallel. Of

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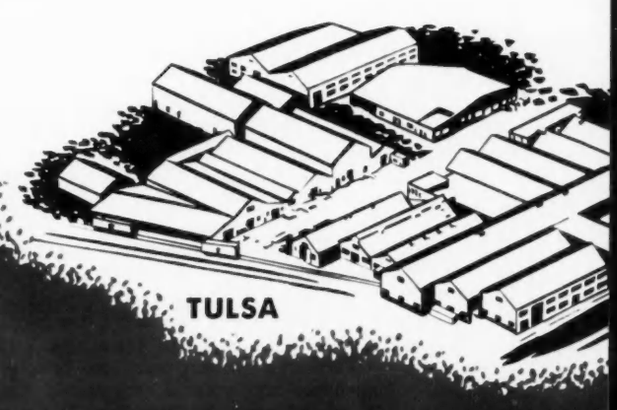

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these two suggestions, keeping the shafts reasonably parallel is the more important. When shafts are not parallel, the belts will be progressively tighter toward one side of the drive.

This does not mean that it is necessary to use a transit to set up V-belt drives. An ordinary steel tape, intelligently used, can insure that the shafts are reasonably parallel. The sheaves can be aligned simply by sighting along the edge of one sheave to the other, or by stretching a string from the edge of one sheave to the edge of the other.

Install the belts. When installing V-belts, slack off on the take-up so that the belts can be put on without forcing. Although V-belts are elastic, they are not rubber bands. Forcing a belt over the groove, as shown on Page 150, can result in breaking the tensile cords in the belt. The belt will then be unable to carry its share of the load, forcing other belts in the set to carry more than their share.

Take up the slack until only a slight bow appears in the slack side of the belts when operating. If the belts slip, tighten them slightly. If they appear mismatched, but have the right range of matching numbers, tighten a little more, and let the drive operate for a while.

After the drive has been installed and has operated for a day or so to give the belts a chance to seat themselves properly in the grooves, retighten the drive and check alignment and parallelism of the shafts.

MAINTAINING THE DRIVE

Once the belts have been installed and the drive has been set up, only a minimum of maintenance will be required—and that maintenance will consist primarily of preventive inspections.

Inspect the drive occasionally. The operator occasionally will want to check to see that the drive is up to speed, that the belts are clean and free from oil and grease, are not rubbing against a belt guard or other obstruction, appear reasonably matched and are in good alignment. He will want to see that the shafts are parallel and are all operating properly. If malfunctions are noted, the operator will want to determine the trouble and correct it.

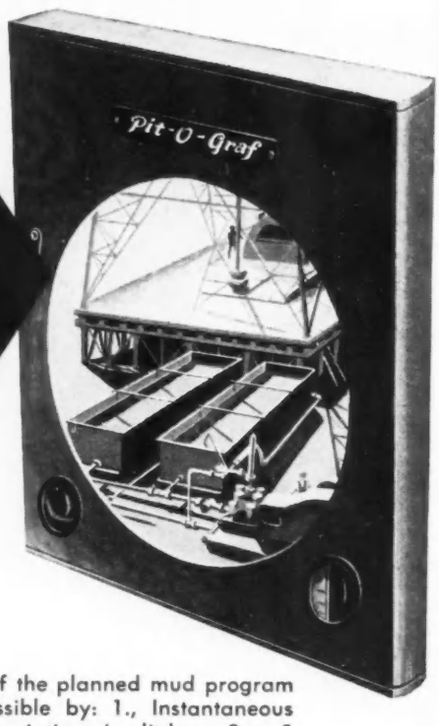
Pump speed should be checked against engine speed to determine if the drive is slipping. If so, a take-up should be made. If the belts are greasy and oil-soaked, they should be cleaned with a gasoline-soaked rag and steps taken to prevent this from recurring. If this can not be prevented, then oil-resistant belts should be installed.

Check sheave grooves before replacing a belt. After the first belt or so has failed, continue to operate the drive—retensioning the remaining belts if necessary—until a replacement set has been secured and it is convenient to shut the drive down and make the replacement. When a set of replacement belts is indicated a careful check of the sheave grooves should be made so that a new sheave can be ordered at the same time if necessary.

A template similar to that shown on Page 150 will prove very useful in checking the sheaves. In using such a template, the proper stub (which is shorter than the minimum depth) to

"Pit-O-Graf"

RECORDS CONTINUOUS INSPECTION OF MUD PROGRAM



Continuous evaluation of the planned mud program by the driller is made possible by: 1., Instantaneous recording of mud pit level variations (as little as 2 or 3 tenths of one per cent in the entire mud system); and, 2, Pit-O-Graf is placed directly in front of the driller for easy observation.

Pit-O-Graf's continuous record helps prevent unnecessary losses of the drilling fluid. Gas or salt water incursions can be detected as much as an hour and a half to two hours before reaching the surface, giving the crew ample time to close the rams and prevent blowouts. Other information such as jetting mud to and from reserve pit, volume displaced thereby, and whether hole is kept full while coming out of the hole is also recorded by Pit-O-Graf.

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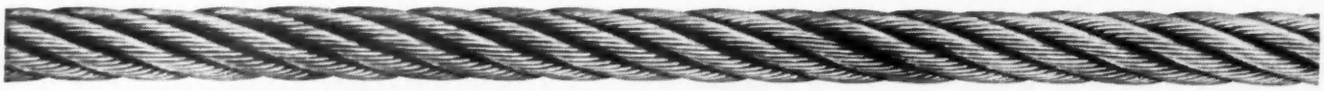
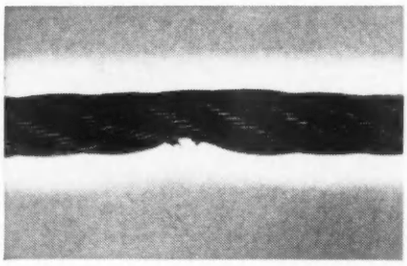
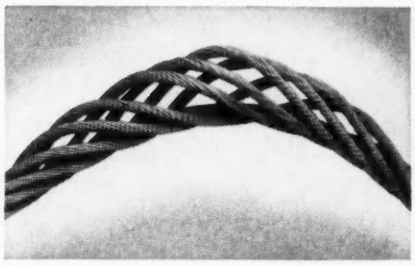


Broken Rules Break More WIRE ROPE Than Capacity Loads

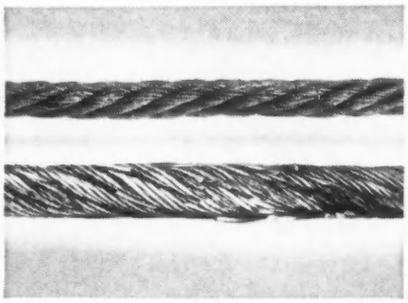


The photo at the left shows what happens when rope is run over or struck by a hard object and crushed. The damage to the strands greatly reduces the service life so carefully built into the rope.

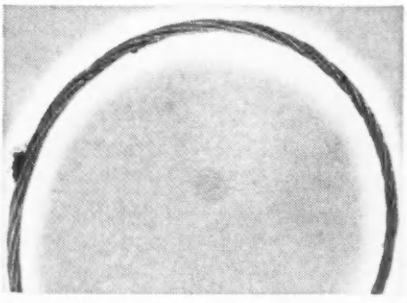
Photo at the right shows how sudden release and rebound from an over-stressed condition may often cause birdcaging. Throwing a loop into the rope is also a major cause of birdcaging. Lang Lay ropes in particular are vulnerable to this abuse.



Here is an example of excessive pinching in the sheave grooves. This rope lasted through only 1-$\frac{1}{2}$ hours of service. To prevent pinching, make sure grooves are not worn deep and that the bearing surface is sufficiently large.



Excessive drum crushing like this occurs at points of cross-over or when rope is wound unevenly. Check for even winding of each layer on the drum to prevent crushing of this type.



When a popped core occurs, continued use causes the rope lay to lengthen out considerably. This displacement of the core is usually caused by load tension being suddenly removed from the rope.

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fit the angle of the groove is found by experimenting. Wear is observed by seating the template squarely in the groove and sighting between the sides of the template and the sides of the groove.

Groove wear of about $\frac{1}{64}$ to $\frac{1}{32}$-inch probably will not seriously affect the service of the drive. When the wear is about $\frac{1}{16}$-inch, it probably will pay to replace or regroove the sheave. In extreme cases, the shoulder is so pronounced that a new belt simply rides on the shoulder, even though the old belts, which wore in the shoulder, seemed to fit well enough. There are obvious advantages in checking for this condition before putting on a replacement set of belts.

Grooves in a sheave may not always wear down uniformly. When checking for wear, it is good practice to check for uniformity of the grooves with a template. If the template does not fit each groove similarly within about $\frac{1}{64}$-inch at the apparent top width, there may be enough differential driving so that regrooving or replacing the sheave will pay good dividends in longer belt service.

No magic necessary. On occasions when inspection shows that a problem exists, common sense usually will suggest the right procedures. For example, a matched set of belts has been operating a few days and one belt seems to be longer than the others. The sheave grooves were checked and found satisfactory before the belts were installed, so possibility of differential driving can be ruled out. An inspection of the apparently long belt is made. Chances are that it was pried over the sheave in installing, and a spot where the belt has narrowed, or "necked down" will be found. This is the point at which the tensile section was damaged on installation.

It may be that on one particular well, or group of wells, frequent take-ups are necessary and drive service is consistently lower than on other wells. This would suggest that the drive is overloaded. The engineer should check the design to see if this is actually a case of overloading. If so, it would pay to use premium-rated belts at the next replacement.

There are occasional situations over which the operator has no control. If the drive consistently runs out of take-up before the belts have failed, it may mean that not enough provisions for take-up have been made. This, and similar problems, should be referred to the design or drilling engineer for review. —**The End**

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About the Author

W. S. WORLEY is chief engineer of the Product Application division of The Gates Rubber Company. He attended Western State College at Gunnison, Colo., and the University of Colorado, where he majored in mathematics and physics. He joined The Gates Rubber Company in 1942 after spending six years in sales work.

A Special Report

Formation Fracturing

HERE IS A REPORT on formation fracturing as practiced today. WORLD OIL has made a special effort to round-up articles covering both the operational and theoretical phases of this all important procedure and it will be noted that each work carries the name of an individual well known in the field of fracturing. Why do we fracture? When is fracturing successful? What are the economic aspects of the procedure? Plus, answers to certain heretofore unsolved problems will be found in the text of this special report.

Formation fracturing represents one of the greatest strides made within the industry during the past decade. And, to the best of our knowledge, this special report represents the first effort to gather and publish all recent data pertinent to the technique.

Many principles—both field proven and theoretical— of formation fracturing will be seen in the following articles; each being an inseparable part of the over-all fracturing picture.

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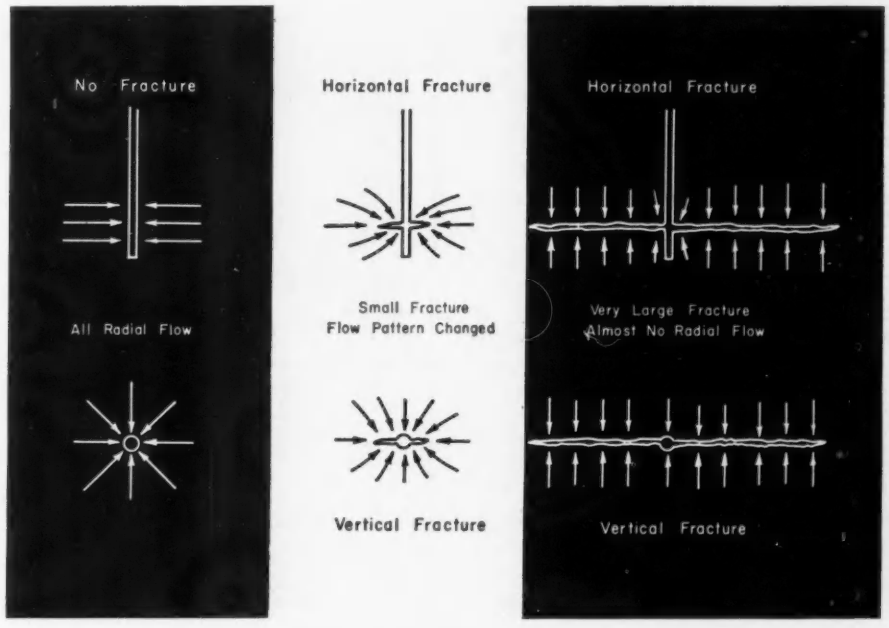

FIGURE 1—Effect of size of fracture on oil flow pattern.

1. What Size Fractures?

Do you design your treatment to fit your well? Returns depend on more than just a cash outlay.

By ROSCOE C. CLARK
The Western Company
Midland, Texas

THE USE OF hydraulic fracturing as a means of stimulating production has proved to be a successful operation. One of the important considerations in its application concerns the effect on production of opening various size fractures around a well bore. This is the aspect to be considered here.

The word *size* relating to fractures may have different meanings for different people. In this instance the size of fractures means the radius or depth of penetration into the formation.

The size of fractures resulting from a hydraulic fracturing operation is dependent upon:

- Matrix permeability
- Characteristics of the fracturing fluid viscosity
- Fluid loss
- Injection rate
- Volume of fracturing fluid used.

These factors are important because the fracturing fluid is lost to a porous and permeable matrix adjacent to the fracture during the fracturing operation. The more fluid that is lost, the less fluid is left to extend fractures.

How fractures increase production. Until recently it has been generally accepted that fractures increase production by performing the following functions:

- Breaking through permeability blocks
- Exposing more formation
- Breaking into more porous or permeable areas.

It is now becoming obvious that

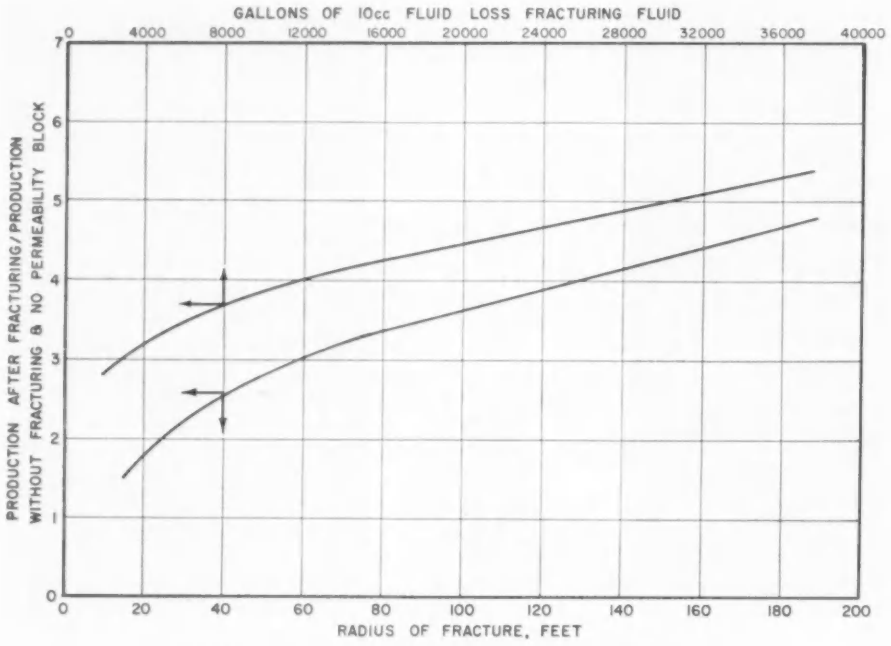

FIGURE 2—Effect of fracture size on production increase.

fractures contribute one other condition that results in a sustained production increase. That is, fractures change the flow pattern of oil to a well bore. Without the presence of a fracture, oil flows radially from the formation towards the well bore. As a result of this type of flow, a large pressure drop is required to cause the oil to flow the last few inches into the well. The creation of one or more large fractures extending into the formation from a well apparently changes this flow pattern and tends to eliminate the radial effects.

Carrying this to extremes, if a formation could be horizontally or vertically fractured from well to well throughout a field, radial flow would be almost eliminated. This effect of fractures on radial flow is illustrated in Figure 1. These effects should prevail under average reservoir rock conditions. Obviously, a large horizontal fracture will be ineffective in reservoirs where there is no vertical permeability. (In this case, a vertical fracture will produce the flow pattern shown for large vertical fractures.) Where there is any appreciable permeability, however, the radial flow pattern will be eliminated except in very thick formations. (Here again vertical fracturing is more desirable and should produce the flow pattern desired.)

Theoretical study. A study has been made by Dr. Paul Crawford[1] to determine the effect of fracture size on productivity. This study was necessarily an electric analog study and, as such, represents conditions of uniform vertical and horizontal permeability. The study, even under these conditions, results in valuable and usable information. Correction factors can be applied to these data which produce answers that are as accurate as the reservoir rock data available.

It is probable that a number of different fracture systems will be developed as a result of a hydraulic fracture job. These fracture systems appear to fall into the following categories:

- One or more vertical fractures
- One or more horizontal fractures
- Random fractures in various planes.

Paul Crawford[1] has shown that the effectiveness of any one size fracture will vary little more than 10 percent regardless of the plane in which the fracture is lying. The following discussion is therefore essentially accurate regardless of the plane of the fracture.

Figure 2 is a graph of the production increase to be expected from one horizontal fracture of various sizes. This does not include the increase that will occur as a result of breaking through a permeability block. It simply illustrates the increase to be expected by extending a fracture beyond the blocked area, and therefore changing the oil flow pattern. Here, it can be seen that the productivity can be increased by a factor of 4 or 5 by altering the flow pattern of oil through a reservoir.

Normally, a small treatment (2000 to 4000 gallons) is adequate to break through a permeability block. When a well has been blocked to any degree, a small treatment should cause a large increase in production. The production thus attained may then be increased 3 to 5 times more by the application of a large treatment. (This consideration is especially valuable when planning retreatments.) The curves in Figure 2 do not show the actual production to be expected from all reservoirs. The curve for each reservoir will be different, the actual figures of each reservoir can be obtained only by experience. Figure 2 does illustrate that the ratio of production increase to increased fracture size is constant and does not decrease with fracture penetration. Thus, larger and larger treatments should produce better and better results.

It is likely that large fracture treatments frequently result in the formation of more than one large fracture. Numerous permeability surveys conducted before and after fracture treatments almost always have indicated that several fractures were created or opened. The opening of multiple fractures in a pay zone usually results in a high flush production immediately following the treatment. This rapidly declines to a stabilized flow rate. An electric analog study revealed the following:

1. When the vertical and horizontal permeability are the same, one 75-foot fracture will produce at the same rate as two 75-foot fractures. As the fractures become larger, some benefit can be derived from two fractures. As the fractures become smaller, no benefit can be gained by producing through more than one fracture. This will be true in pay zones having thicknesses ranging between 0 and 150 feet and *in wells having 100 percent permeability block* except at the point of the fractures.
2. When the horizontal permeability is three times the vertical permeability, two 75-foot fractures will produce about 1.25 times the fluid that can be produced by one 75-foot fracture. Three 75-foot fractures will produce little more than two. This is true in pay zones up to 150 feet thick and in wells having 100 percent permeability block

except at the point of the fractures.

3. When the horizontal permeability is five times the vertical permeability, two 75-foot fractures will produce twice as much as one, however, three 75-foot fractures will produce only 1.1 times as much fluid as two. This is true in pay zones up to 150 feet thick and in wells having 100 percent permeability block, except at the point of the fracture.

Considering the above under the conditions of the horizontal permeability being three times the vertical permeability, any number of gallons (10 cubic centimeters fluid loss fluid) displaced into one fracture should be about 1.1 times as effective as the same number of gallons displaced into two fractures. Looking at it another way, 10,000 gallons displaced into one fracture should be almost as effective as 20,000 gallons displaced into two fractures.

The above, of course, would not be completely true in the case where a formation contained many horizontal shale or other impermeable streaks. In this case, fracturing each permeable streak should prove somewhat more effective than described above. In cases where impermeable streaks are continuous for some distance, each pay zone between each streak should be considered separately.

None of the above illustrations can be applied directly to any known reservoir. These figures do, however, point out one important fact: the greater the fracture size, the greater the increase in productivity that can be expected. This is supported statistically in actual practice.

Established Trends in Fracturing. In the Permian Basin of West Texas and New Mexico, fracturing jobs were first conducted using 1000 to 2000 gallons of fluid displaced with 150 to 300 horsepower. The sizes of these jobs has continually increased both in fluid volume and in injection rate until now 30,000 gallons volumes displaced with 3000 hp is not uncommon.

Several jobs using 75,000 gallons and 5000 hp have been conducted and more are planned.

In the Anadarko Basin, Oklahoma, fracturing was initiated using 750 gallons and 150 hp. The size of the jobs has continually increased to an average size job of 8000 gallons and 1200 hp.

About the Author

ROSCOE C. CLARK, JR., director of research for The Western Company, has been with the firm two years. He received his M.S. degree in petroleum engineering from the University of Tulsa, and subsequently served as service engineer with Dowell Incorporated; research engineer with Stanolind Oil and Gas Company; and supervising research engineer with Continental Oil Company.

Other areas such as Kansas and Wyoming have experienced similar trends.

During most of this continual increase, the majority of fracturing jobs employed residual refined oils as the fracturing fluid. Many of these oils did not possess low fluid loss characteristics and thus resisted loss to the porous matrix by viscosity alone. Fracture extension using these oils depends more upon the injection rate than on the volume of the fracturing fluid used. For example, 20,000 gallons of high fluid loss fracturing fluid injected at 5 barrels per minute will produce very little, if any, more fracturing than 10,000 gallons of the same fluid injected at the same rate.

This is probably the most important cause of the present difference between Anadarko and Permian Basin treatments. In the Anadarko Basin, most treatments are conducted down tubing. The friction loss thus developed restricts the injection rate and renders ineffective much larger treatments than 8000 to 10,000 gallons.

In the Permian Basin, treatments are conducted down casing. This provides for higher injection rates which results in larger effective volumes of fluid to produce larger fractures. As pointed out before, the trend in West Texas is still to larger and larger treatments. In some cases, treatments now are being restricted because of the limited capacity of 5½-inch casing to conduct sand laden fluids. Considering specific instances, Wilsey and Bearden[3] applied this principle in their design of large fracturing treatments in the Pine Island field, Louisiana. The creation of large fractures allowed them to produce a very low permeability reservoir at an economic rate.

Actual practice is, therefore, in agreement with theory that larger and larger treatments produce better and better results. In order to provide much greater extension of fractures, it is becoming necessary to employ fracturing fluids which resist penetration into porous matrix. Many companies are already insisting that the fracturing fluids used in their wells must display low fluid loss properties.

Cost Saving Applications. In designing treatments for maximum economical size fractures using refined oils, treatment costs can be maintained at a minimum by balancing injection rate with volume of fluid. For example, consider fracturing a formation having 100 millidarcy permeability and 3000 pounds per square inch bottom hole pressure with a 100 centipoise viscosity residual oil at a bottom hole fracturing pressure of 4000 psi and a surface pressure of 2000 psi. Identical results should be obtainable using 30,000 gallons of oil injected at 10 barrels per minute; 20,000 gallons of oil injected at 15 bpm or 10,000 gallons of oil injected at 30 bpm. Assuming that the oil could be purchased at 11 cents per gallon and sold to the pipe line at 6 cents per gallon and 30,000 pounds of sand is used in all treatments, the treatment costs should be:

30,000 gal., 10 bpm — $3150
20,000 gal., 15 bpm — $2550
10,000 gal., 30 bpm — $2725

From this analysis it can be seen that a $600 saving is possible by selecting the proper treatment.

Davis, Reynolds & Coffer[2] have presented data to illustrate the radius of fractures that can be obtained by varying the injection rate and the volume of fluid used. Figure 3 shows the relationship between injection rate and fluid volume for various size fractures under the conditions described in the above example. These curves probably do not represent the behavior to be expected from an actual reservoir. Each reservoir, however, should have its own characteristic curves similar to those shown in Figure 3, which can be obtained with

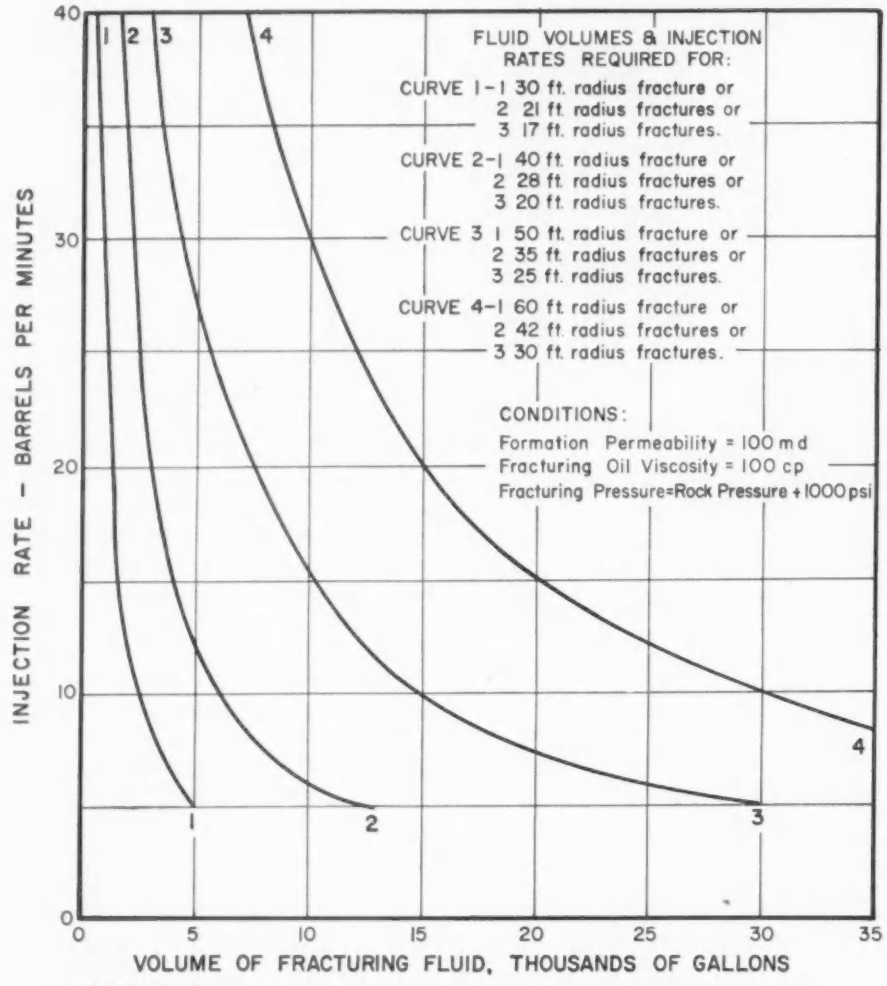

FIGURE 3—Fluid volumes and injection rates required for various size fractures.

reasonable accuracy by theory corrected by experience in fracturing in that reservoir. This type of data can then be used to produce maximum economic results as illustrated above.

It has been concluded that increasing the size of a fracture will produce a corresponding increase in production after break-through of any existing permeability block. It cannot, however, be stated that increasing the amount of money spent on a fracture job will produce a corresponding increase in return. This is because of allowables placed on the producing rates of wells.

For example, if a well has an allowable of 50 barrels of oil per day it would normally be uneconomical to design a fracture job to produce a recovery rate of 1000 bopd. Rather, it would be better to design a treatment that would result in the ability of the well to produce its allowable until a later stage of depletion. At that time, considerably more data would be available for determining the effectiveness of another fracturing job and for designing that job.

Future Considerations. If it could be established that formations could be fractured horizontally for great distances, hydraulic fracturing programs could be planned on a reservoir or on a lease basis, rather than on a per well basis. This possibility is not at all far fetched as many reservoirs contain conditions favorable to this practice. For example, advantage could be taken of long shale streaks extending through a reservoir. It should be feasible to fracture along a shale-sand interface for great distances. This undoubtedly happens accidentally many times during hydraulic fracturing operations. Many long sections containing considerable quantities of shale have been consistently successfully fractured.

One company in the Texas Panhandle has found that when completing and fracturing in the Morrow Sand the best results are obtained when the shale, as well as the sand, sections are perforated. It is entirely conceivable that when perforating the shale one or two long fractures are created along the shale-sand interface instead of several small fractures that are created in the sand body itself when the shale is not perforated. This type of fracturing would, in all likelihood, provide an economic recovery rate sufficiently attractive that well spacing could be increased considerably.

For example, 40-acre spacing could very likely, in many reservoirs, be increased to 80-acre spacing by fracturing half of the distance to each offset well. According to Davis[2] et al, such a fracture would require 135,000 gallons of 10 cubic centimeter fluid loss fracturing fluid. This would cost about $10,000 for the oil and sand. In a 100 well, 6000-foot depth field, the savings should amount to at least $3 million. The possibility of saving this kind of money makes further study of deep penetration fracturing attractive.

Based on the results of this study, it was concluded that:

1. Well productivity should increase in direct proportion to the size of the fractures formed until the fracture has been extended half the distance to the offset wells.
2. Generally better results can be obtained from one long fracture than from several short fractures.
3. Fracturing fluids having low fluid loss characteristics are necessary in order to develop long or greatly extended fractures.
4. The size of fractures can be increased by increasing the volume of fracturing fluid and/or increasing injection rates.
5. When using fracturing fluids not having low fluid loss characteristics, injection rates must be increased along with an increase in the volume of fracturing fluid used in order to obtain optimum results.
6. Generally, it is less expensive (when using refined oils) to increase fracture size by increasing injection rates rather than by increasing the volume of fluid used.
7. There are considerable profits to be realized by the development of techniques for producing deep penetrating fractures.

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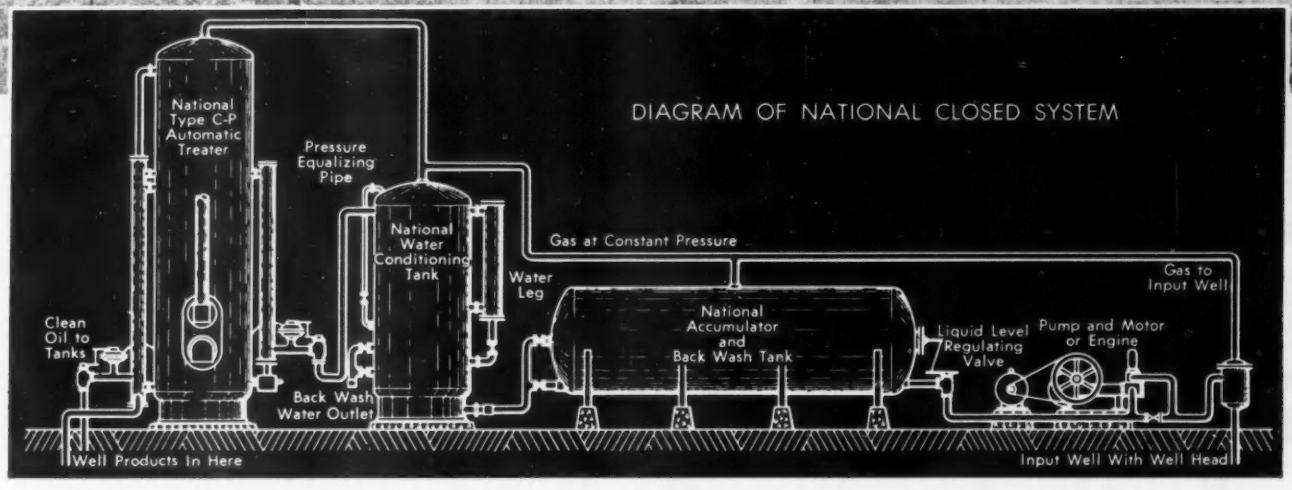
DIAGRAM OF NATIONAL CLOSED SYSTEM
National Type C-P Automatic Treater
Pressure Equalizing Pipe
National Water Conditioning Tank
Gas at Constant Pressure
Water Leg
Gas to Input Well
Clean Oil to Tanks
National Accumulator and Back Wash Tank
Liquid Level Regulating Valve
Pump and Motor or Engine
Back Wash Water Outlet
Well Products In Here
Input Well With Well Head

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Many drilling operations in the basin are located at virtually inaccessible sites. Access roads are cut around and over the mesas that are characteristic of the region.

2. What Fracturing Has Done For the San Juan Basin

This vast New Mexico-Colorado area owes much of its development to hydraulic fracturing.

By B. G. TAYLOR
Halliburton Oil Well Cementing Company
Farmington, New Mexico

THE SAN JUAN BASIN covers a large portion of northwestern New Mexico and extends into southern Colorado, occupying an area of some 2500 square miles. Several articles have been written about the basin describing its characteristics and importance as a gas producing region. Much of its development has been due to the application of hydraulic fracturing. This stimulation method has experienced constant change in techniques and use with each variation leading to improved efficiency and better economy.

Prior to the use of hydraulic fracturing, most of the wells were completed in open hole and the formations shot with nitroglycerine. Sometimes these sections extended over a distance of 700 to 800 feet. This method of completion did obtain some favorable results but at great expense.

The first hydraulic fracturing jobs on these gas producing formations had been performed in the winter of 1951. Volume-wise, these were small as compared with those of today, and used gelled crudes as the fracturing medium. Wells treated were in a boundary area that did not respond as desired. As a result, the use of this principle was retarded until the latter part of 1953.

When fracturing had come into its own as the best means of stimulating production and was used consistently for this purpose, methods of completion remained the same. Fracturing operations were conducted through casing or drill pipe into open holes. In the Mesa Verde group, where three formations exist, a gas drilling program had been brought about to combat lost circulation problems.

The uppermost formation (Cliff House) was gas drilled and fractured with diesel oil through a drillable full bore packer; then tested, the packer drilled and more holes made through the Menefee and Point Lookout formations. When the total depth had been reached, a drillable packer was then set in the open hole and the remaining formation fractured.

The method of fracturing through drill pipe and packers, using volumes of approximately 20,000 gallons of diesel oil and 15,000 pounds of sand on each formation at injection rates of 7 to 12 barrels per minute, continued until midyear, 1955. At that time, casing programs had changed and methods of completion altered.

The producing formations were now drilled prior to setting casing. Pipe was set through and cemented up past the top producing interval; then the sands were individually perforated and fractured. Each was treated independently by perforating the bottom sand and fracturing, then setting a bridge plug, perforating the next sand above, fracturing and so on up the hole until all zones were completed.

The program for setting casing immediately changed the outlook on fracturing techniques. Where jobs had been run with one truck, now four trucks were utilized to fracture through the casing with larger volumes of fluids employed, usually 40,000 gallons of diesel oil and 60,000 pounds of sand with correspondingly increased injection rates.

Water Brings About New Proce-

Multiple truck fracturing job on gas well in typical San Juan Basin terrain. Here the unique sand and water fracturing technique was used. The trend toward faster injection rates, as reflected in the number of pumping units, still continues.

dures. In September, 1955, the revolutionary idea of trying water for the sand carrying medium was introduced. This was tried with a certain degree of apprehension. It proved very successful. Although this idea had been contemplated for some time, it had not been applied because of the bentonite in the formations. After the experimental jobs gave equally good initial results, water practically replaced diesel oil as the sand carrying medium.

With the cost of the fracturing fluid greatly reduced, additional pumps were used to acquire higher injection rates of from 50 to 75 barrels per minute. These higher rates materially helped in increasing the production of the wells.

The San Juan Basin has two main gas producing formations—the Pictured Cliffs at about 2000 feet and the Mesa Verde at 5000 feet. Completion methods have been different, with the Pictured Cliffs being open hole completions and the Mesa Verde having casing set through the formations and perforated. However, increasing number of Pictured Cliffs' wells are now being completed in the same manner as the deeper pay.

The Pictured Cliffs is treated through the casing with an average volume of 40,000 gallons of water with a sand to water ratio of 1.5 pounds per gallon. Beginning with the hole dry and pumping 5 to 10 barrels of water, sand is then added, starting with a ratio of 1.0 pound per gallon and increasing it to 1.5 to 2.0 pounds per gallon, depending upon existing pumping pressures. The casing and open hole are then flushed to complete the job.

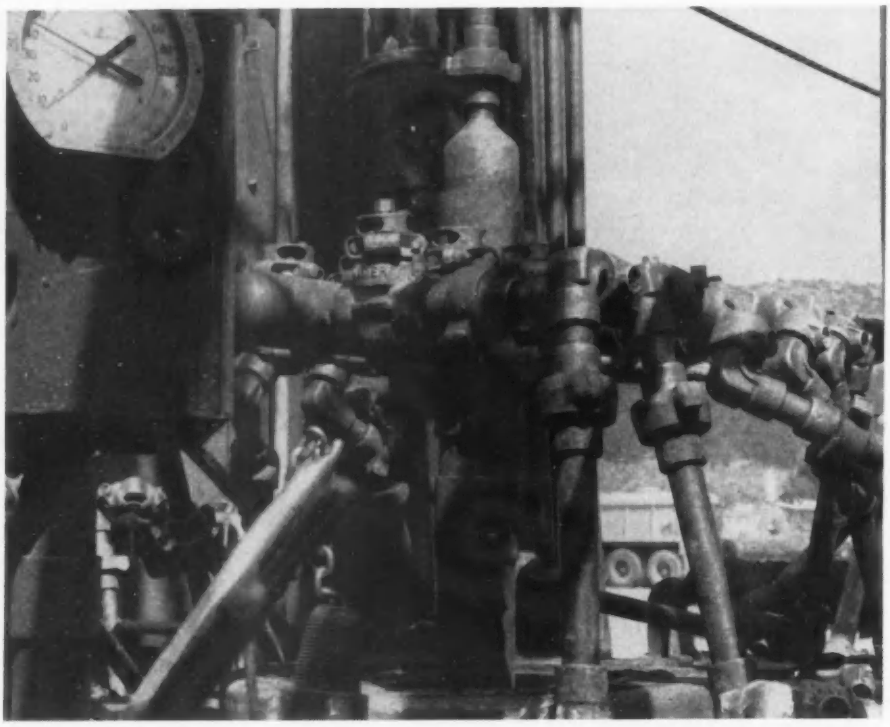
Mesa Verde wells are fractured through the casing, starting with the lower formation and staging the jobs upward. The bottom zone is perforated and fractured; then, if sand and water are used, a drillable bridge plug is set by wire line and the next upper zone perforated and fractured.

Volume-wise the jobs run about 40,000 gallons with over-all sand to water ratio of 1.5 pounds per gallon. A 20-40 mesh sand is used on the Mesa Verde and Pictured Cliffs. At the beginning, 20-40 mesh sand was used on the Cliff House until sand-outs became a regularity. Now a 40-60 mesh sand is used in most cases. The ratio of sand to water is usually lower for this formation and treatments require higher pressures. In both cases the ratios are increased or reduced according to pumping pressures.

Water does not have sufficient viscosity to suspend sand; therefore, it is necessary to rely upon velocity and careful mixing and proportioning of the two ingredients for satisfactory job completion. Immediate changes in sand concentration often are required, which can be accomplished only with a continuous type variable ratio pro-

About the Author

B. G. TAYLOR joined Halliburton Oil Well Cementing Company in 1946. Later he served with the U. S. Marines as a captain during the Korean emergency. Following receipt of his degree in mechanical engineering from the University of New Mexico, he returned to Halliburton and is now district engineer at Farmington, New Mexico.



Individual discharge lines are connected from each pump to the fracturing head installed on the casing so that maximum injection rates can be maintained.

portioner. Much of the success with water fracturing fluids can be attributed to this equipment.

Initial results of fracturing with water compare favorably with those where diesel oils were used. Decline curves are being observed closely and appear to be comparable; however, the elapsed time has not been sufficient to form definite conclusions. Even though the economics of sand and water jobs have been reduced almost to a minimum, water leaves something to be desired especially in formations containing bentonite. Development of inexpensive additives for control of bentonite swelling is being vigorously pursued with various chemicals having been used towards this end with, as yet indeterminate results.

Recently a number of wells have been fractured using water without a propping agent. In some cases the water, analyzed before and after fracturing, contained greater amounts of dissolved solids after recovery. Initial results of this type treatment have proven to be equal to those obtained by fracturing with water and sand. However, the ability of a well, fractured without a propping agent, to maintain its production level, has not been fully determined.

Operational Difficulties. Conditions under which men and equipment must operate in the basin are extreme. During rainy seasons, mountain roads become hazardous and flash floods frequently block passages through dry washes. The average distance to jobs is approximately fifty miles and during the periods of bad weather twenty hours are sometimes required to reach location. In winter months the roads and mountain passes are much more dangerous and often impassable because of ice and snow. Temperatures range as low as 25 to 30 degrees below zero and the efficiency of both men and equipment is reduced drastically.

Water as a fracturing fluid presented new problems during cold weather. Its freezing in storage tanks and manifolds was prevented by the installation of gas burners. After setting up for the fracturing job, it has been imperative that routine matters such as testing lines and checking blowout preventers be accomplished with a minimum loss of time to prevent ice from forming in the lines and creating a block between displacement pumps and the wellhead.

Field Expansion and Development. Field development has been rapid as a result of hydraulic fracturing with the extent demonstrated by increased productive area. At one time it was believed that fairly definate field limits could be established by non-commercial wells but hydraulic fracturing has changed this picture. Many wells completed now with initial production "too small to gage" have had their flow increased to commercial values after fracturing. Outer extremities of the field, therefore, are still flexible.

Some typical fracturing results throughout the basin are shown in Table 1.

TABLE 1
Typical Fracturing Results

Formation	Potential Before Fracturing (MCF Gas)	Potential After Fracturing (MCF Gas)
Pictured Cliffs.....	1,500	22,500
	170	4,027
	481	21,000
	250	11,450
	19	1,632
	Show	3,937
	84	7,050
Mesa Verde Cliff House	470	3,150
	170	2,830
	Show	5,000
	Show	2,000
	255	2,300
Point Lookout.....	362	4,922
	98	3,400
	496	5,459
	240	9,396
	Show	3,490
	Show	7,158

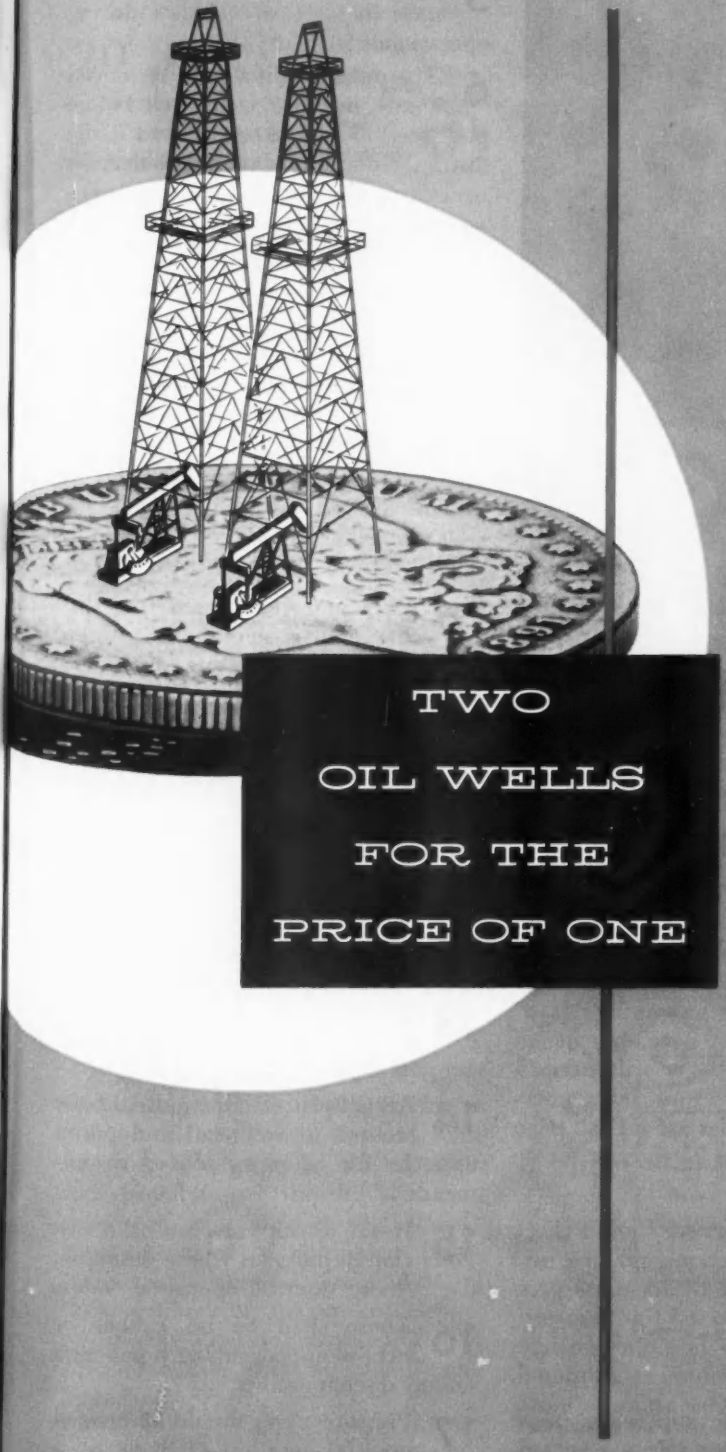
Gas reserves within the San Juan Basin have been increased tremendously. Calculations of these have been made but are not available for publication. Although the drilling pace fluctuates in intensity, it has remained relatively stable for the past eighteen months. Reports state that approximately 750 wells were completed in 1955 and an estimated 1000 will be drilled in 1956.

The construction of large transmission lines to California and the Pacific Northwest will make this source of energy available to sections of the nation heretofore practically untouched, thereby resulting in increased activity as these outlets are established.

Conclusions. Hydraulic fracturing has very definitely played an important part in the development of the San Juan Basin. Continuous study in regard to its application has provided an economical method of recovering available gas reserves.

Fracturing is by no means a cure-all and has its limitations. Although its application within the area has been quite successful, some wells have not responded. A dry hole cannot be made to produce but where formations exist that have porosity and gas is present, hydraulic fracturing is accomplishing the purpose for which it was designed. It will continue to be used until some superior procedure is devised. —**The End**

A PROGRESS REPORT ON OILMASTER DUAL ZONE PUMPING EQUIPMENT



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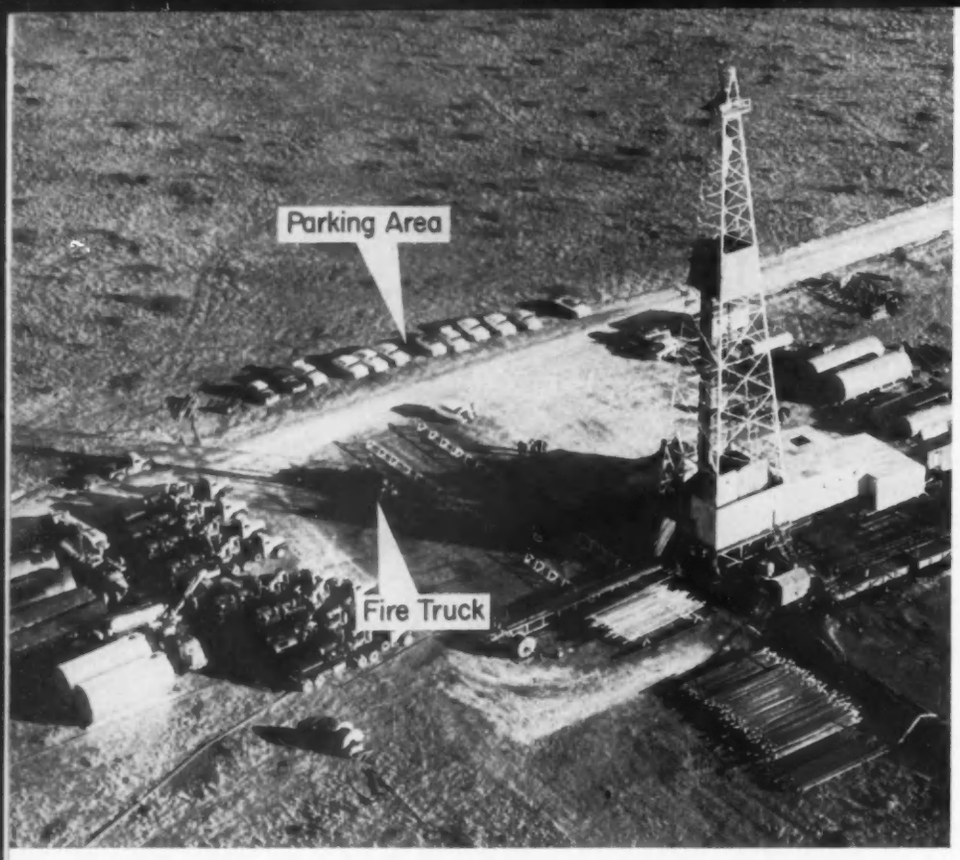


Trucks and equipment shown in typical position for a formation fracturing operation. Note location of automobiles away from immediate working area. Fire truck is located in shadowed area between pumping equipment and well.

3. Check These 27 Rules For Safety in Fracturing

4000 jobs a month + high pressure + high flow rate + oil — safety can = TROUBLE

MILLIONS OF DOLLARS have been made as a result of formation fracturing. In direct contrast to this, however, millions of dollars worth of equipment and resources have been lost due to fires and explosions resulting from the necessary formula—high pressure plus high rate of flow plus oil. These factors, combined with terrific line vibration and a constant source of ignition (notably pump exhaust), inevitably will lead to death and destruction if not properly guarded against. Due to the ever-present menace, operators have turned their attention toward solving and controlling hazards introduced by "frac" operations.

The combined efforts of Humble Oil & Refining Company's operating and staff personnel produced a set of rules and procedures covering "frac" operations. Future development of this operation probably will necessitate revising this set of safe procedures, but these rules are a basis from which to work. The 27 rules as set up now are:

1 Company supervisor should check all well connections, making sure that the fittings are of adequate pressure rating for expected frac pressure; and then make the necessary changes before sand-frac equipment is ordered.

2 The company supervisor shall conduct a safety meeting including all men on location before sand-frac operations are begun. This meeting should consider layout of equipment, proper operating procedure, possible hazards, and the designation of jobs and responsibilities.

3 All sand-frac pumping operations should be conducted in daylight hours.

4 Smoking is prohibited during operation and is restricted to 150 feet up-wind of well and related equipment before and after operation.

5 All matches and cigarette lighters must be left in vehicles during operation.

6 The pulling unit should be moved a safe distance from well before pumping operations are started if the district superintendent considers it necessary.

7 Blowout preventer is to be used where applicable and checked for proper pressure rating, rams and operating condition.

8 It is recommended that all diesel pumps be equipped with emergency shut-downs and spark-proof ignition systems.

9 Pumping trucks and tanks should be located cross-wind from the well and as far as location will permit —100 feet is desirable.

10 All connections used on discharge lines shall have a minimum test pressure rating of 10,000 pounds per square inch.

11 All discharge lines should consist of N-80 tubing or higher test rating. Care should be taken to insure against rod-cut or excessive corrosive damage on previously used pipe.

12 Each discharge line should have a full swing at well and truck manifold.

13 Arrangement of discharge lines should be such that they will not pass under trucks.

14 All discharge lines should be secured at wellhead and pump and the use of pipe socks is recommended.

15 Install check valve on each discharge line and where desirable, use remote control operating valve.

16 There shall be no rubber or steel-wrapped rubber hoses used on any discharge lines.

17 Pressure gages should be hooked up 100 feet up-wind or at a safer position if available from the

well using check-valve type connections. The connecting hose must be tied down within two feet of the gage.

18 All personnel, vehicles and equipment not needed for the frac operations should be removed to a safe distance; and vehicles equipped with radios must remain at a minimum distance of 200 feet up-wind from well and pumping equipment during operation.

19 If water is sprayed on the ground, it should be restricted to the vicinity of pumping trucks.

20 Suitable fire-fighting equipment must be placed in strategic locations, in good working condition, and with men trained and in position to use it.

21 A pressure test of two times the expected frac pressure must be made, not to exceed test pressures of equipment, before operations are started. All leaks shall then be repaired after pressure is released, and all oil spills must be covered with dirt.

22 No one should stand on or near discharge lines while under pressure.

23 Each pump operator must remain at his designated position while pump is in operation, intermittently glancing at the treating engineer for possible signals.

24 When well or line pressure exceeds the test pressure of the equipment used, the pumps shall be shut down immediately.

25 Air should never be allowed to get into suction lines.

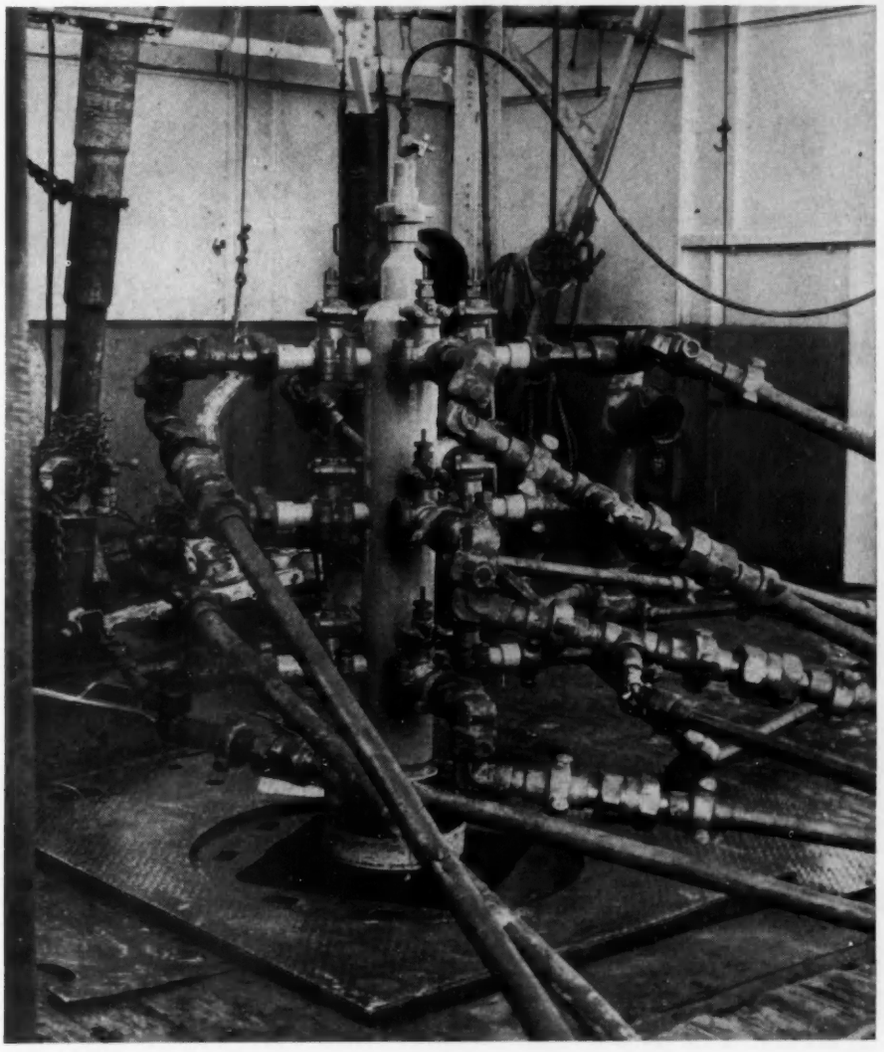
26 Flushing oil should be allowed to weather in tanks over 24 hours if possible.

27 When pressure of 2000 pounds or more remains on tubing overnight, the tubing should be adequately secured.

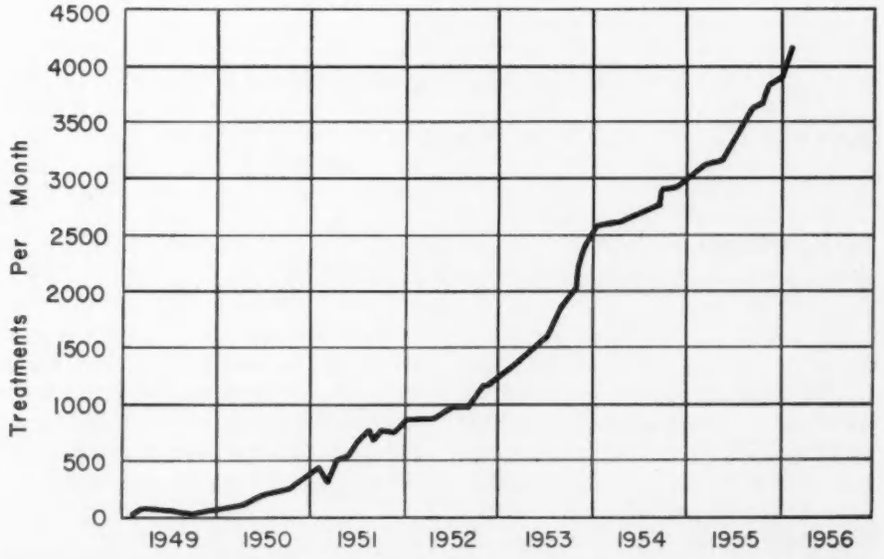
Although these rules cover most of the existing hazards, the fact remains that at this time there are still some major problems to be solved. Two such problems are the elimination of sources of ignition, such as truck exhaust—redesign of equipment, insulation, water cooled, installation of flash arrester, or the use of electric equipment—and the development of a non-volatile carrying agent and flush fluid.

ACKNOWLEDGMENT

Reprinted from May, 1955, issue of *Safety Information*, Humble Oil & Refining Company publication. Illustrations courtesy Dowell Incorporated.



An important key to safety in fracturing operations—10,000 psi minimum test fittings coupled with full swing connections. Well head connections must be carefully inspected and pre-tested before the operation is under way. Personnel must be restricted from the wellhead area during the operation.



Above is seen the terrific upswing in fracturing operations during the past seven years. And, with this activity increase, the operator is faced with a greater number of safety hazards peculiar to a fracturing job. The possibility of serious personnel, equipment and well damage is an ever present problem. However, by respecting certain fundamental safety edicts, frac jobs can be, and are being carried out with minimum accident frequency rates.

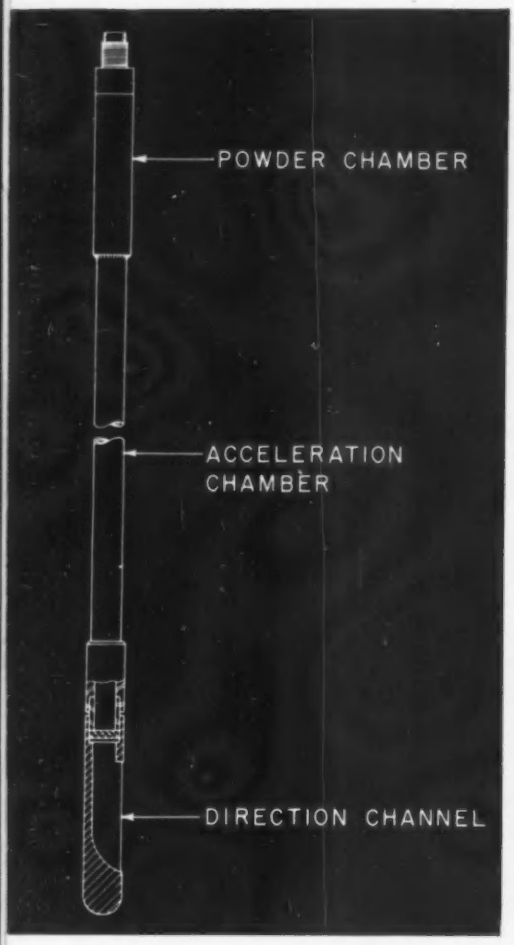


FIGURE 1—An assembly drawing of the wire line fracturing gun which turns missiles 90 degrees into the formation.

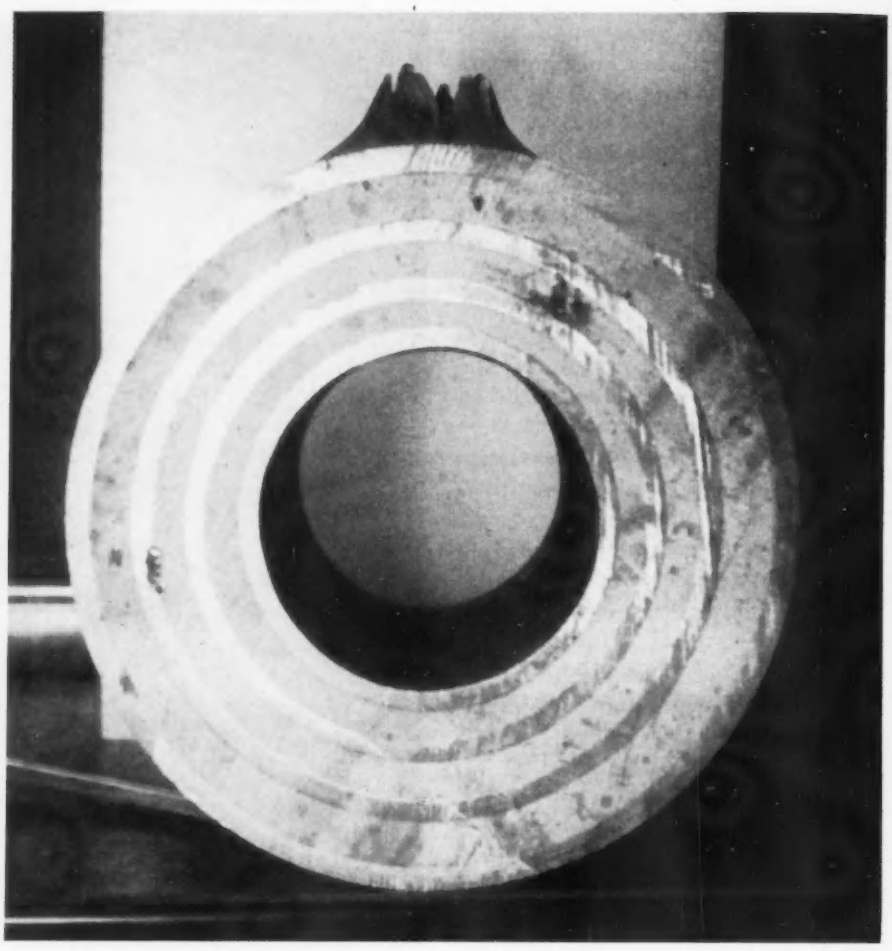


FIGURE 2—Standard casing, banded together with neat cement, was target used to show direction change of missile.

4. Perforating 'Around the Corner'

A high velocity missile turns a corner to deliver its 'Sunday Punch' and KO's a 15-ton concrete block.

By RAYMOND L. DOYLE
Welex Jet Services, Fort Worth, Texas

MILLIONS OF DOLLARS are being invested annually by service companies to help solve some of the problems confronting the petroleum industry. The formation fracturing tool, which shoots around corners, is a result of some of these research dollars. Built to provide large hole size and mechanical fracturing of the formation, it fills some of the industry's needs.

In most instances, perforating requirements are met adequately and effectively by standard methods. However, there are many conditions in which extreme penetration and larger hole size are desirable and necessary. Some examples of this are tight formations, conditions of excessive contamination of the well bore, or as a preparatory treatment for fluid fracturing or acidizing. The latter requirement is becoming increasingly important as various new techniques are being developed. The problem of breaking down the formation and displacing the fracturing material properly is a vital one.

Realizing the bounds imposed by the diameter of the well bore on a horizontally positioned charge, it was reasoned that if a missile could be actuated vertically and then change its direction, these bounds would be removed. In other words, man's age old quest for a gun that would "shoot

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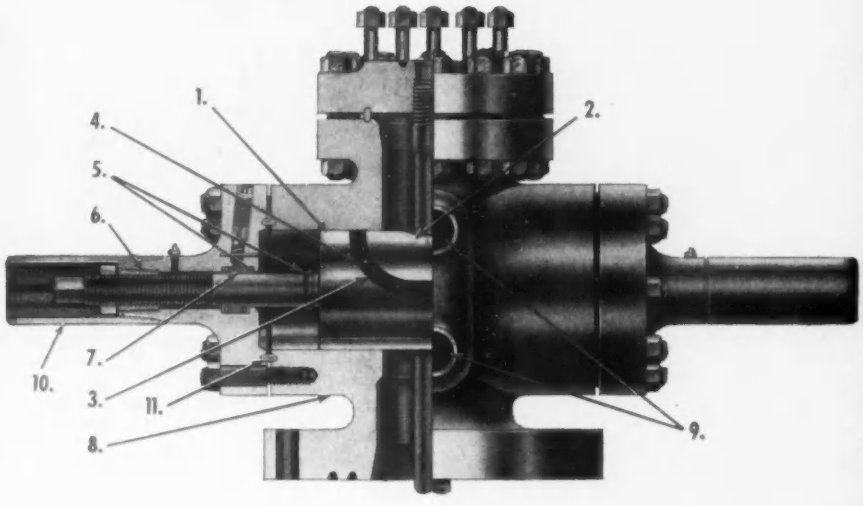

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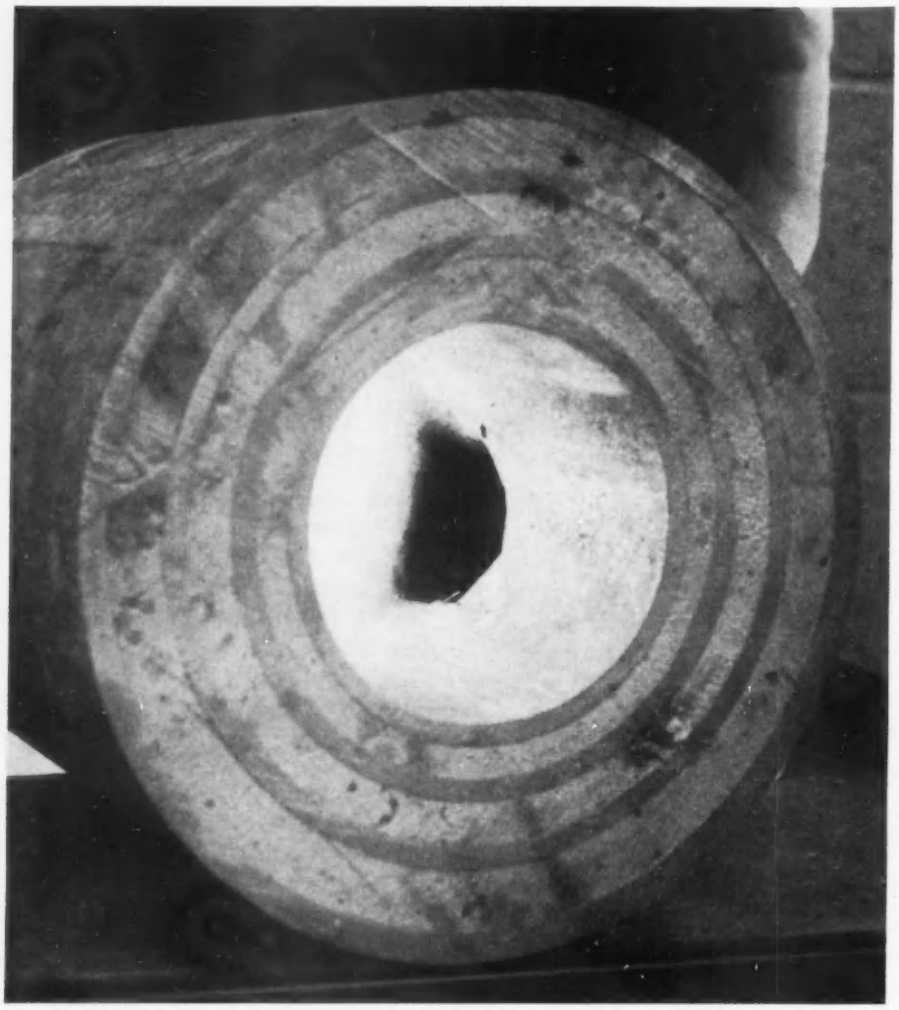

FIGURE 3—Large diameter (3-inch) entrance hole and smooth condition of inner string of casing is shown in concentric-string target.

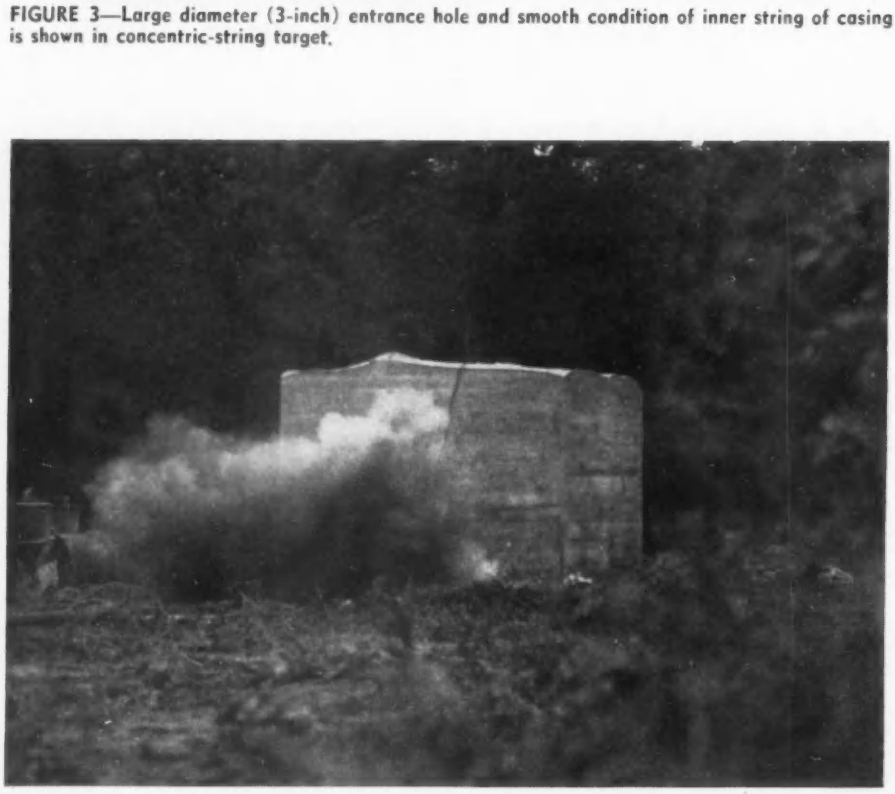

FIGURE 4—Mechanical fracturing methods are being used to an increasing degree in the oil field. The tremendous fracturing force of this formation fracturing gun is illustrated by the fissuring already begun in a 30,000-pound concrete block at the instant of detonation.

around a corner" now has found itself in the oil business.

First came the carrier or means of positioning the charge at the desired depth. Since a solid missile was to be used, it was determined that the carrier should be composed of three segments—a power chamber, an accelertion chamber, and a means of directing the accelerated missile. (See Figure 1).

It also was decided that since the acceleration chamber could be any length within certain practical limits, progressive or slow burning powders could be utilized. These advantages were offered:

1. Low internal or working pressures, lessening possibility of damage to the casing or well bore.

2. Use of more powder due to these low pressures.

3. High velocities and resulting high kinetic energies could be attained, since the missile could be acted on a longer period of time.

Following a period of intensive search for the proper charge—missile—acceleration chamber length relationship, the optimum physical components were selected. These components were selected on the basis of velocity and over-all performance. With the first two components, powder chamber and the acceleration chamber, determined, it was then necessary to find a means of turning the missile consistently. Two major factors had to be considered:

1. Since a directing action is more consistent than a deflecting one, a groove or channel was desirable.

2. Due to the forces involved, the direction channel had to be expendable. Since the fragments would necessarily remain in the well bore, the material should be removable. After many tests and trials it was decided that cast iron met all the requirements.

There followed another period of testing to determine the proper charge—missile—direction channel relationship to give a 90 degree direction change. In order to establish this relationship, and as a means of observing the pathway of the missile, a series of concentric-string targets were made. Standard casing, banded together with neat cement was used. (See Figure 2). The muzzle of the gun was positioned in the target and the gun fired.

The large diameter three-inch en-

FIGURE 5—A 30,000-pound concrete block after one shot from fracturing gun shows what can be expected in a formation. The 5½-inch N80 casing, which was imbedded at ground level in the block, was not damaged.

trance hole, and the smooth condition of the inner string of casing may be observed in Figure 3, which was one of the targets actually used in tests. Consistent performance such as this was indicative that similar results could be expected in well-cemented casing.

As a means of observing the fracturing force of the new tool, a 30,000 pound block of concrete was poured, with a piece of 5½ N80 casing imbedded horizontally in it at ground level. This block was poured from concrete using 2½ parts sand to one part cement and allowed to set five days. Figures 4 and 5 show the block before and after the first shot. Actually Figure 4 was taken at the instant of detonation, and a fissure may be observed at the top of the block. This was an indication of the fracturing force of the tool, and again an assurance of the safety in using the tool since casing was undamaged.

After the design and testing of various fluid seals and other mechanical components, the tool was ready for field testing. The wells were selected because of their failure to respond to other treatment. In some cases, tight sands resisted break-down with treating fluids. The gun was used, and in every case these initial break-down pressures were lowered considerably.

In some cases, desired injection rates could not be achieved, and the tool was used to facilitate the placing of fracturing fluids into the formation. Some wells were selected because of cement block or other contamination of the area around the well bore. These tests indicated that the tool was effective and would do its job, providing evidence of the merits of the tool.

A variation of this tool has been developed in which the tremendous energy is utilized as a down hole junk shot. The direction channel is removed, a special missile inserted, and the change is complete. Bridge plugs, packers, rock bits, and other fish have been rendered removable by use of this tool. This is a fast, economical service and usually results in a substantial savings to the operator.

The directional gun has been used for both production and junk shooting in a large number of areas and under a wide variety of conditions. When any of the following conditions are present it provides an excellent remedy:

1. Need for large hole size.

2. Need for mechanical fracturing of tight formations.

3. Cement or fluid contaminated producing zone.

4. Expected trouble when fluid fracturing or acidizing.

5. Need for junk shot.

—The End

About the Author

RAYMOND L. DOYLE, assistant to the vice president of operations of Welex Jet Services, Inc., has been with the Company since 1953, although he worked part time from 1949 to 1951 while attending Texas Christian University. He received a B.A. degree in physics from T. C. U. in 1951 and served with the U. S. Navy during World War II.

Part of the careful planning that goes into a fracturing treatment is demonstrated by the coordinated efforts of men and machines. Here a close watch is kept on the injection pressure to assure type of treatment designed.

5. Planning a Fracture in a New Area?

Do you know what it takes to plan such a job? It will pay you to know what goes into your well . . . and why.

By G. L. GORE,
Dowell Incorporated, Denver

A VARIETY OF materials and procedures are available for hydraulically fracturing a well. To get the greatest benfit from such a process the correct materials must be chosen for each job. The various materials, their properties and applications are presented here with a list of fracturing problems and their solutions.

When planning a fracturing treatment, materials and procedures are usually chosen on the basis of results obtained on neighboring wells, producing from the same formation. In an unproven area in which fracturing treatments have not been attempted, however, this is not possible. In order to plan the treatment properly it is necessary to correlate the producing formation with other similar formations that have responded to fracturing.

A detailed preliminary study of the new formation is required. The company drilling the well may conduct this study, or furnish formation samples to the service company for complete laboratory analysis. Information gained in this manner should be carefully tabulated into an accurate description of the formation. The following items normally are included in such a study:

- Chemical and physical analyses of the formation.
- Core data—permeability, porosity, water and oil content.
- Characteristics of the formation fluids—emulsifying tendencies, sand carrying ability, fluid loss and gelling ability.
- Compatability of formation crude with foreign fracturing fluid.
- Other well information—mud losses during drilling, drill stem test results, bottom hole temperature, completion procedure and initial production.

After these data have been com-

piled and evaluated, specific treating recommendations can be made. These may include:

- Type and quantity of breakdown fluid
- Type and quantity of fracturing fluid
- Chemical additives
- Size and quantity of sand
- Anticipated injection rate and pressure
- Amount of flush fluid

The treating technique is based on such recommendations together with certain fundamental procedures applicable to all fracturing treatments. In general, each fracturing treatment consists of the following basic steps:

- Breakdown
- Fracture
- Over-flush

Breakdown consists of injecting fluid until either a pressure break is noted or a constant injection rate and pressure are established. The purpose of the breakdown is to open up formation passages sufficiently that they will initially accept the fracturing materials. After the breakdown has been accomplished, 500 to 1000 gallons of fracturing fluid without sand is injected.

In a wildcat area, tubing and a retainer should be used to protect well equipment from excessive pressures. This will limit the injection rate to 10 to 12 barrels per minute, regardless of bottom hole injection pressure. Under these conditions sufficient crude oil (usually about twice the tubing volume) to establish the breakdown rate and pressure, should be pumped.

The fracture fluid containing sand is then pumped. Three functions are required of a fracturing fluid. It must be able to:

- Open a fracture
- Carry sand
- Return readily to the well bore

The following types of fracturing fluids have been successfully applied to wells producing from sand formations:

- Aqueous gels
- Hydrocarbon gels
- Emulsions
- Refined oils
- Lease oils

Aqueous gels consist of water or acid which have been thickened using a gelling agent, normally a carbohydrate or cellulose derivative. After a predetermined period, this type of gel thins, either as a result of acid reaction with the formation or bacteria mixing into the gel.

About the Author

GEORGE L. GORE, district engineer for Dowell Incorporation at Denver, received his B. S. degree in electrical engineering from Oklahoma A&M College in 1949. After graduation, he joined Dowell at Great Bend, Kansas, as junior service engineer. Following a training period he was promoted successively to service engineer, development enginer and petroleum engineer. Assuming his present duties in 1955, he has been active in the field testing and improvement of new well completion and workover procedures.

Hydrocarbon gels may consist of gasoline, kerosene, diesel oil or lease oil which has been thickened by a metallic soap, or the salt of a fatty acid. Such gels are thinned by contact with formation water or mineral acid, or may be diluted by formation crude. These hydrocarbon gels normally have much better sand carrying ability, and lower fluid loss, than the crude from which they were made.

Emulsions play a very important part in the fracturing picture. Controlled emulsions are designed to break after entering the formation. In general they consist either of acid emulsified with kerosene, or oil emulsified with water. When acid is used, the acid phase may be varied to between 10 and 90 percent by volume and between 1 and 15 percent by strength.

In oil-water emulsions, the water and emulsifying agent usually comprise less than 4 percent of the total volume. The acid-kerosene emulsion may be broken by one of the acid reaction products, or as a result of the emulsifying agent, being adsorbed onto the formation. Oil-water emulsions may be broken by any chemical tending to reverse the emulsion. Also, these emulsions tend to break as they are pumped through fine sand.

Refined oils used as fracturing fluids are paraffin base crudes from which the very high and very low ends have been removed. This product, usually referred to as fuel oil, makes an ideal fracturing fluid when diluted to the desired viscosity with diesel oil. Most refined oils have less tendency to create emulsions than does crude, possibly because of the fine solids removed during the refining process. Care should be taken to select a refined oil having a pour point at least 20 F. below the formation temperature, in order to prevent the precipitation of wax crystals.

Although lease oil has occasionally been used as a fracturing fluid, its sand carrying ability is very poor. Formation permeability restricts its use unless a fluid loss control agent is added.

In opening a fracture the fluid loss of the fracturing fluid is very important. If the fluid can be confined within the fracture rather than escaping into the matrix of the rock, the fracture will be opened wider and extended farther. This results in a more successful fracturing treatment. Treatments of 20,000 gallons of fracturing fluid, containing a fluid loss control agent, at an injection rate of 10 bpm, have proven to be as effective as 40,000 gallon treatments at 40 bpm using a fracturing fluid without such an additive. The improved decline curves which have resulted point to increased use of fluid loss control agents in the future.

Fracturing fluids containing acid have been extensively used to further stimulate production from acid-soluble formations. Their use in sandstone has been limited. Even in sandstone formations, however, acid may be employed to dissolve secondary deposition, although the matrix may be insoluble.

Fluids presently being used to fracture sand wells in the Rocky Mountain area, in descending order based on the extent of use, are:

- Refined oil
- Lease oil (with fluid loss control additive)
- Acid-kerosine emulsions or gelled acids
- Lease oil

The use of lease oil containing fluid loss control additive is increasing, and

in 1956 it is expected to be the fracturing fluid used most extensively.

Generally speaking, the more sand displaced, the better are the results from the fracturing treatment. Round-grained, 20-40 mesh Ottawa sand is commonly used. This sand when packed has a permeability of 105 darcys. Approximately one pound of sand per gallon of fracturing fluid is customary. For treatments in loose sands, concentrations of 5 to 8 pounds per gallon are not uncommon. Frequently, in tighter formations one-half pound per gallon is sufficient to drain all production that can enter the fractures.

The use of over-flush to follow the sand laden fluid is still open to debate. One contention is that no over-flush should be used. This allows the sand to remain in the critical area of the well where it is considered most necessary. Others feel that over-flush is needed to displace the sand farther back into the formation so that the injected sand will not be produced back into the well bore.

The quantity of flush being used normally is about twice the tubing volume. Surface tension reducing agents and emulsion breaking agents, which often are added to the flush oil, greatly facilitating clean-out.

Many times it is necessary to use special treating procedures to meet the requirements of a specific well. If quantities of mud are known to have been lost during drilling, or if the production after completion is much less than indicated by drill stem tests or offset wells, a mud acid treatment preceding the breakdown is desirable. Mud acid is a mixture of hydrochloric and hydrofluoric acids with special chemical additives. It is designed to destroy the colloidal properties of any residual mud cake and make it permeable to fluid.

Treating the formation with 250 to 500 gallons of mud acid makes possible the injection of the breakdown fluid without resorting to excessively high treating pressures. If exorbitant breakdown pressures are encountered during a fracturing treatment, mud acid is injected into the formation, and after spending, is swabbed out before continuing the breakdown. In some cases, the mud acid is merely displaced ahead of the fracturing fluid during the breakdown.

Various fracturing problems are encountered from time to time. The table lists some of these general problems and possible corrective measures.

Problem	Conditions of Treatments	Corrective Action
Screen-out	Excessive fluid loss	Add fluid loss control agent or increase injection rate
Screen-out	Sand fillup	Increase viscosity or sand carrying ability of fracturing fluid. Increase injection rate.
Screen-out	Using best possible fluid	Preclean using Mud Acid. Use 40-60 mesh sand. Increase injection rate.
Screen-out	Using best fluid, small sand, and good injection rate.	Reduce sand concentration.
Difficult clean-up	Emulsion	Use emulsion breaker in oil squeeze. Use different fracturing fluid. Use emulsion breaker before attempting fracture.
Sharp production decline	Good initial production, indicative of multiple shallow fractures.	Use fracture fluid having improved fluid loss characteristics.
Water production increasing	Separate oil and water zones	Use selective cementing techniques, employing a cement-oil slurry.

Theory

Reservoir Scientists Seek Answers to Fracturing Phenomena

- What is the usual fracturing pattern and which type is considered most effective?
- Does fracturing effect gas cycling or water-flooding?

Questions Have Arisen. Since the advent of commercial reservoir fracturing techniques, questions have arisen as to whether the fractures have any effect on a water flooding or gas cycling program. Some have expressed the opinion that fracturing may be disastrous to a water-flood. Others feel that the volume above a "pancake" fracture will be displaced in the economic operating time.

Quantitative answers to the above questions are desired in order to determine whether to fracture and the engineering specifications of the fracturing treatment. After

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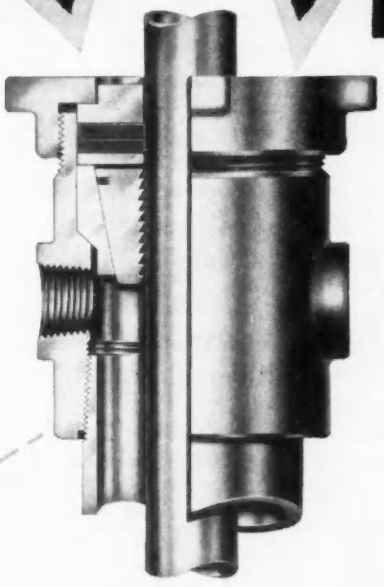

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fracturing, it is necessary that the engineer obtain data which will permit an estimate of the nature of the fracture, whether vertical or "pancake," effective size, length and orientation of the fracture. After determining the type and orientation of the fracture, it is a matter of economics and engineering to determine whether to enlarge or plug the fracture, use a north-south or east-west flood, or a five-spot or line-drive flood utilizing this well, or whether the well should be closed in.

Work has been presented to show the effects of perfect circular horizontal fractures on pattern sweep efficiences and conductivities[1]. However, since field data indicate that all horizontal fractures are not circular, it is necessary to study a few elliptically fractured systems.

These studies report the results for a line-drive pattern, first with only one well (input or output) fractured. They then deal with systems in which both wells (input and output) are fractured. In water-flooding or gas cycling the swept area after break-through and the effluent composition of the producing wells largely determines the fraction of the reservoir swept at abandonment conditions. These data are presented here for elliptically fractured wells.

Fractured input wells and then output wells are considered with flow both parallel and perpendicular to the fractures. The presentation is concluded with data on the "Effect of Horizontal Fractures on Production Capacity."

Reservoir Analog. In studying fractured reservoirs, a potentiometric model was used in which a thin copper disc represented the "pancake" fracture, and a wire was used as the unfractured well. The reservoir model was 30 inches long, 20 inches wide and approximately one inch deep. The injection and producing wells were on opposite ends of the reservoir.

Work in studying the effect of horizontal fractures on reservoirs shows that for the case of thin reservoirs the effect of a fracture corresponding to an isopotential will not affect the remaining isopotentials to any substantial degree.

A thin reservoir as determined in the model was one where the pay thickness divided by the well spacing was approximately 0.02[1]. For a 10-acre well spacing and the line-drive pattern used here, this would correspond to a pay thickness of about 15 feet. Three dimensional potentiometric model studies indicate that for thick reservoirs (200-400 feet), close well spacing and small fracture radii that the volume above and below the fracture may be displaced after long periods of fluid injection.

For thin reservoirs and large fractures the isopotentials and streamlines are such that substantial fraction of the volume above or below the fracture may not be included in the swept area at abandonment for normal injection periods.

In securing the basic data, copper strips were formed to give the desired isopotentials. After achieving these isopotentials, the potentiometric model data were used to estimate the swept area and effluent gas composition.

The application of the potentiometric model to reservoirs of this type assumes that the reservoir is a uniform homogeneous media, steady-state conditions exist, the mobility ratio is one, and gravity effects are neglected. The conductivity of the fracture is considered to be much greater than the conductivity of the matrix. The data obtained may correspond to reservoir conditions only in such proportion as the flow in the model corresponds to flow in the reservoir. *Continued on Page 182*

About the Authors

Crawford

Wieland

Landrum

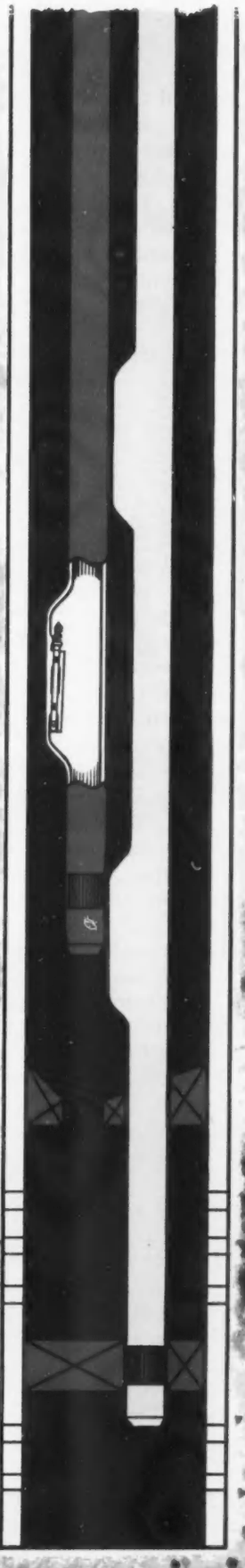
DR. PAUL B. CRAWFORD received a B. S. degree in chemical engineering from Texas Technological College in 1943. He received his M.S. degree from the University of Texas in 1946 and a Ph.D. from the same university in 1949. Before becoming assistant director of the Texas Petroleum Research Committee in 1952 he was connected with Cyanamide and Chemical Corporation and Magnolia Petroleum Corporation. He is assigned to the Texas A. & M. Division of the Texas Petroleum Research Committee. His works have been published in numerous technical journals.

•

DENTON R. WIELAND put in a hitch in the U. S. Army Air Forces and a stint in the oil fields as a roughneck for Magnolia Petroleum Company before enrolling at Texas A. & M. in 1949. He received his B.S. in petroleum engineering in 1953 and his M.S. degree in 1956. He is now working toward a Ph.D.

•

BOBBY L. LANDRUM has been connected with the Texas Petroleum Research Committee since 1953 when he received his B.S. degree in physics from Texas A. & M. He received his M.S. degree in 1954. He also is working on an Air Force-sponsored project for the Research Foundation in spectroscopy, the subject of his M.S. work.



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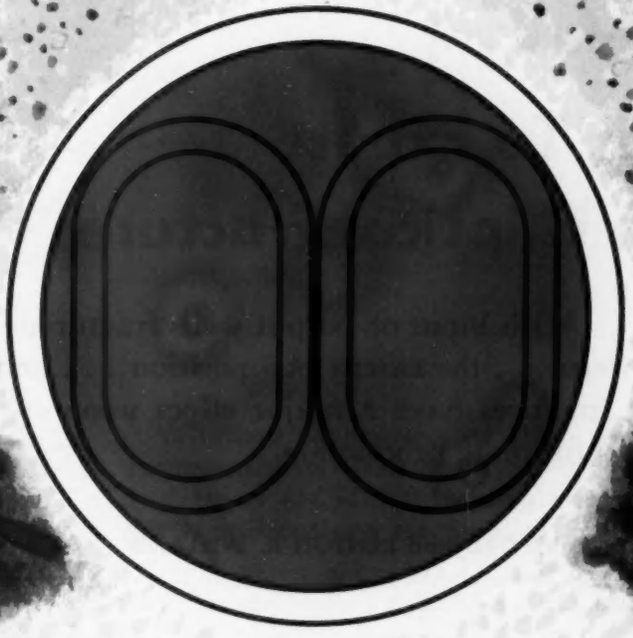

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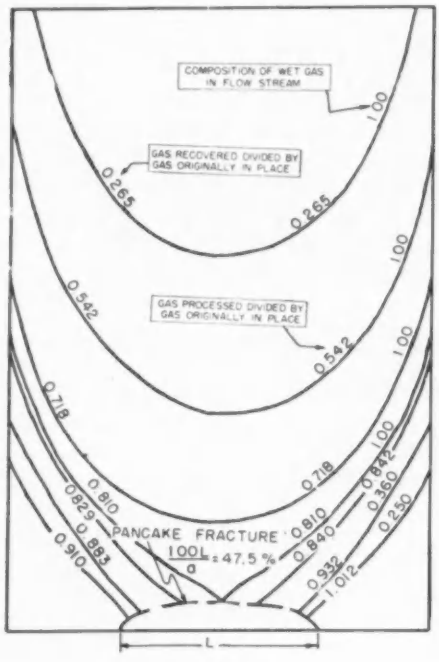

FIGURE 1

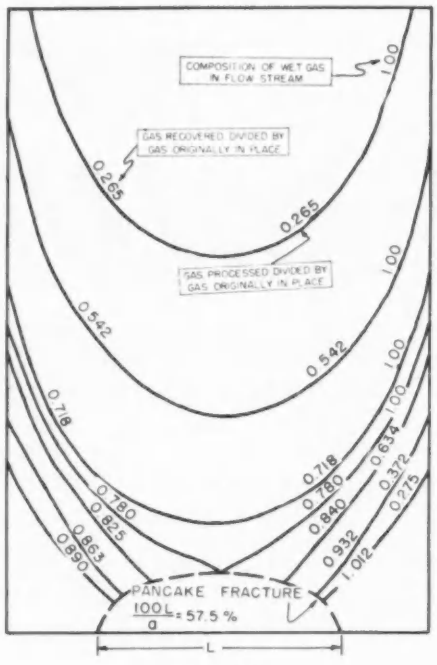

FIGURE 2

Theory

What To Expect From Elliptical Fractures

With input or output wells fractured in a line drive pattern . . . the extent . . . position . . . and size of elliptical fractures have a major effect upon sweep efficiency and ultimate production.

By PAUL B. CRAWFORD and DENTON R. WIELAND
Texas Petroleum Research Committee
Texas A. & M. College, Division, College Station, Texas

THIS POTENTIOMETRIC model study was made to estimate the effect of elliptical fractures on the swept area in water-flooding or gas cycling horizontally fractured thin reservoirs. An elliptical fracture existed at the input well, and the producing well was assumed to be unfractured.

It was found that if a well was fractured with an elliptical fracture with a major axis perpendicular to flow, the sweep efficiency may be larger or smaller than that of the unfractured pattern, depending on the size and shape of the elliptical fracture. If the major axis of the elliptical fracture were parallel to flow, it was found that the sweep efficiency may be reduced approaching zero as the fracture connected the output well.

Elliptically Fractured Reservoir Performance. Figure 1 shows the position of the dry gas at various instances in cycling an elliptically fractured thin reservoir. The input well is unfractured—the output well is fractured. The major axis of the elliptical fracture is 47.5 percent of the distance "a", the distance between adjacent input wells.

The inset figures show the gas recovered divided by gas originally in place, gas processed divided by gas originally in place, and the fractional composition of wet gas in the flow stream. For this pattern the wet gas composition will remain near 100 percent until 81 percent of the reservoir has been swept. The sweep efficiency of the unfractured pattern is 70.2 percent.

The creation of a fracture of the type shown is expected to result in an increase of sweep efficiency by about 11 percent. When the gas recovered divided by gas originally in place is equal to 0.91, the fractional composition of wet gas in the flow stream would be near 0.25. This would occur when approximately 1.012 volumes of gas originally in place had been processed.

It is evident from this figure that the creation of elliptical fractures perpendicular to flow may increase the cycling performance of the reservoir above that expected had no fracture been created. This is only true for certain ranges of swept areas.

Since the mobility ratio is one, the performance indicated on Figure 1, and other figures shown, will be the same regardless of whether the fractured well is the production or injection well. This will be demonstrated later.

In Figure 2 the input well is unfractured, and the output well has a large elliptical fracture. The length of the major axis of the elliptical fracture is 57.5 percent of distance "a". With this fracture, breakthrough is expected to occur when 78 percent of the reservoir has been swept.

When the gas processed divided by gas originally in place is equal to 0.84, the gas recovered divided by gas originally in place is expected to be near 0.825. The fractional composition of wet gas in the flow stream is expected to be near 0.634.

When the volume of gas processed is equal to the volume of gas originally in place, the swept area will be near 0.89 and the fractional composition wet gas in the flow stream will be near 0.275.

Figure 3 shows the position of the dry gas at various times when an elliptical fracture exists at the output well and the input well is unfractured. The major diameter of the fracture at the output well is 57.5 percent of

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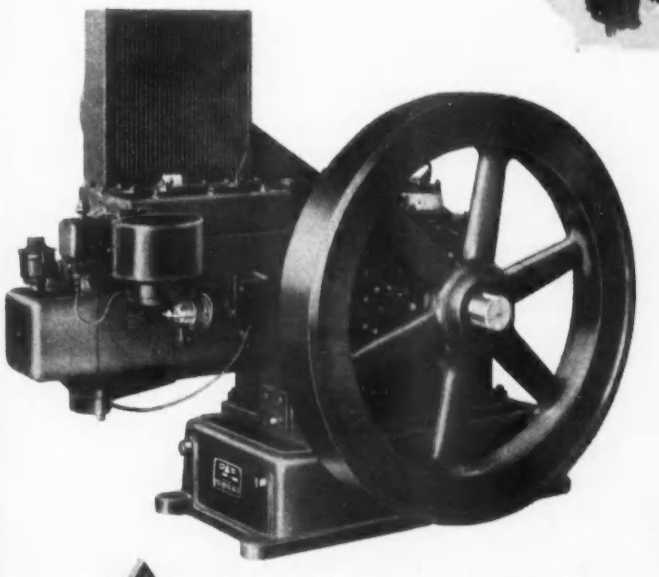

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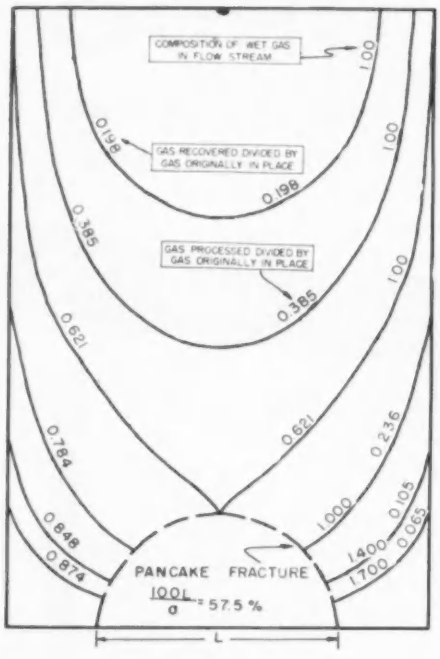
COMPOSITION OF WET GAS IN FLOW STREAM
GAS RECOVERED DIVIDED BY GAS ORIGINALLY IN PLACE
GAS PROCESSED DIVIDED BY GAS ORIGINALLY IN PLACE
PANCAKE FRACTURE
100L/a = 57.5 %
L

FIGURE 3

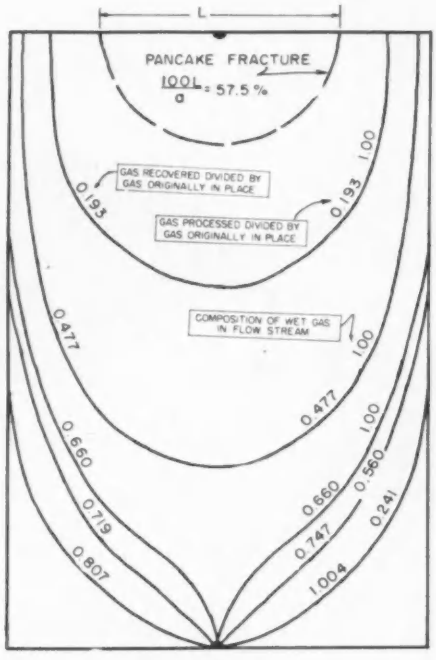
L
PANCAKE FRACTURE
100L/a = 57.5 %
GAS RECOVERED DIVIDED BY GAS ORIGINALLY IN PLACE
GAS PROCESSED DIVIDED BY GAS ORIGINALLY IN PLACE
COMPOSITION OF WET GAS IN FLOW STREAM

FIGURE 4

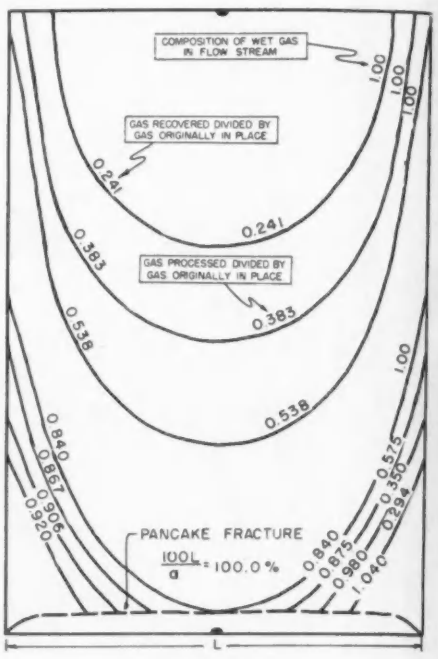
COMPOSITION OF WET GAS IN FLOW STREAM
GAS RECOVERED DIVIDED BY GAS ORIGINALLY IN PLACE
GAS PROCESSED DIVIDED BY GAS ORIGINALLY IN PLACE
PANCAKE FRACTURE
100L/a = 100.0 %
L

FIGURE 5

"a". This is the same as the major diameter of the fracture shown in Figure 2. However, the minor diameter of the fracture in Figure 3 is approximately twice the minor diameter of the elliptical fracture in Figure 2.

Figure 3 shows that the sweep efficiency for this pattern is expected to be near 62.1 percent. When the gas processed divided by gas originally in place is equal to 1.700, 87.4 percent of the pattern area may be swept, and at this time the fractional composition wet gas in the flow stream would be near 0.065.

The fracture in Figure 4 is the same as that in Figure 3 except the input well is assumed to be the fractured well. On this pattern break-through is expected to occur when 66 percent of the gas originally in place has been recovered.

The swept area after break-through and the fluid composition shown in Figures 3 and 4 should be identical. The variations shown are experimental and averages of values were used to plot the data for Figures 9 and 11. The results of either pattern were approximately 2 percent from the mean value.

Figure 5 shows the position of the dry gas at various times when an elongated elliptical fracture of the type indicated at the producing well has been created. This fracture extends 100 percent of the distance "a" shown. The swept area at break-through would equal 84 percent of the pattern area.

When 1.04 volumes of gas have been processed, the gas recovered divided by gas originally in place is expected to be near 0.920. At this time the fractional composition of wet gas in the flow stream is indicated to be near 0.294.

Note how the wet gas/dry gas interface extends outward along the "pancake" fracture after break-through. For this particular pattern a high sweep efficiency may be expected and a very rich gas anticipated until a large percent of the area has been swept.

Figure 6 shows "pancake" fracture in which the minor axis is approximately 20 percent of the distance "a," as shown. The major axis is more than twice as great as the minor axis. The sweep efficiency for this pattern is indicated to be 63.8 percent. When the gas processed divided by gas originally in place is near one, a swept area of 0.806 may be expected.

At this time the effluent composition is indicated to be near 28 percent wet gas. When 1.7 pore volumes of gas have been injected, the swept area may be near 0.924 percent and the effluent gas is near 10 percent wet gas.

Figure 7 shows the positions of dry gas for an irregular shaped "pancake" fracture. This elongated "pancake" fracture extends 46.6 percent of the distance between the input and output wells. The width is 50 percent of the distance between adjacent injection wells. The sweep efficiency of 33.4 percent is less than half of that which might be observed had no fracture been created.

When the volumes of gas processed divided by gas originally in place is near 0.91, the gas recovered divided by gas originally in place is expected to be near 0.630. At this time the gas effluent is expected to be near 27 percent wet gas. After 2.2 pattern pore volumes of gas have been injected, the swept area would be near 78 percent and the produced well effluent would be near 7 percent wet gas.

It is evident that large swept areas may only be obtained by cycling considerable quantities of gas. This may not be desirable in every case since the percent wet gas may prohibit the continuation of the program.

Figure 8 is similar to Figure 7 except that Figure 8 shows the dry gas position when the fractured well is the input well and the unfractured well is the output well. In Figure 8 the sweep efficiency is near 34.3 percent. The data and performance of Figure 7 and Figure 8 should be identical and the differences existing are due to experimental error.

Figure 9 shows the cycling performance of horizontally fractured thin reservoirs for the line-drive pattern. The abscissa shows the gas processed divided by gas originally in place which also may be a time coordinate. The

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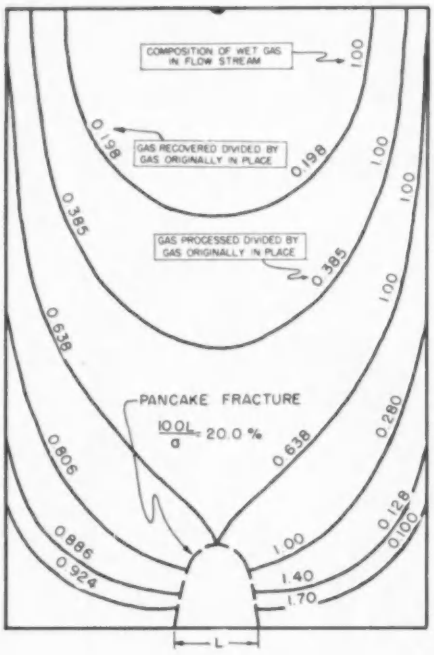
COMPOSITION OF WET GAS IN FLOW STREAM
GAS RECOVERED DIVIDED BY GAS ORIGINALLY IN PLACE
GAS PROCESSED DIVIDED BY GAS ORIGINALLY IN PLACE
PANCAKE FRACTURE
100L/a = 20.0 %
L

FIGURE 6

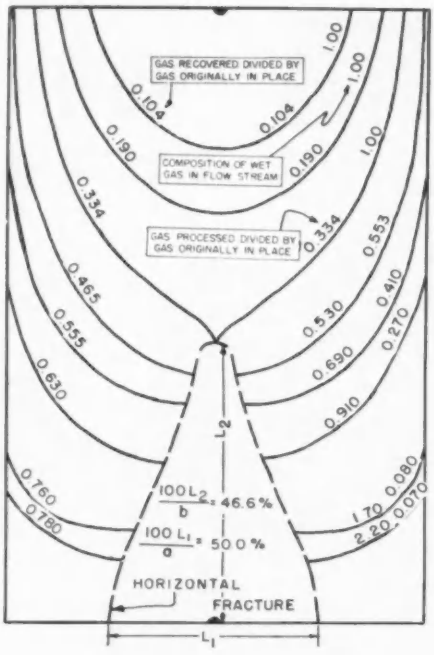
GAS RECOVERED DIVIDED BY GAS ORIGINALLY IN PLACE
COMPOSITION OF WET GAS IN FLOW STREAM
GAS PROCESSED DIVIDED BY GAS ORIGINALLY IN PLACE
100L2/b = 46.6 %
100L1/a = 50.0 %
HORIZONTAL FRACTURE
L2
L1

FIGURE 7

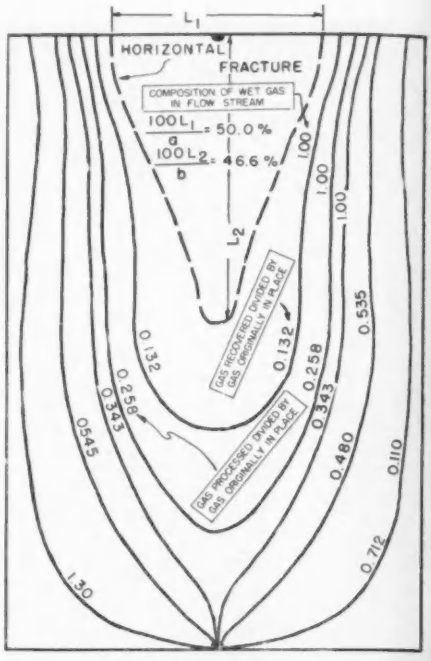
L1
HORIZONTAL FRACTURE
COMPOSITION OF WET GAS IN FLOW STREAM
100L1/a = 50.0 %
100L2/b = 46.6 %
L2
GAS RECOVERED DIVIDED BY GAS ORIGINALLY IN PLACE
GAS PROCESSED DIVIDED BY GAS ORIGINALLY IN PLACE

FIGURE 8

ordinate shows the wet gas recovered divided by gas originally in place which is also the fractural area of the pattern swept. Curves 1, 2, 3 and 4 provide the performance for the patterns described in Figures 1, 2, 3 and 4, respectively.

When the gas processed divided by gas originally in place is equal to one, the swept area may vary between 0.80 and 0.90, depending on the nature of the elliptical fracture. The value of 0.80 is indicated for the type of fractures shown in Figures 3 and 4, and the value of 0.90 is expected for fractures of the type shown in Figure 1. When the gas processed divided by gas originally in place is equal to 1.4, the swept area may vary between 0.85 and 0.95, depending on the nature of the fracture.

Figure 9 indicates that in order to achieve an 85 percent swept area, the gas processed divided by gas originally in place must equal 0.88, 0.92, 1.04 and 1.35 for fractures of the types shown in Figures 1, 2, unfractured pattern and Figure 4, respectively.

Figure 9 shows that it may be possible to sweep large areas in cycling horizontally fractured thin reservoirs, but to do so it may require the injection of large quantities of additional fluid.

Figure 10 shows the performance when cycling thin reservoirs having fractures of the types shown in Figures 5, 6, 7 and 8. Attention is called to the very poor performance indicated by the fracture shown in Figures 7 and 8. When the gas processed divided by gas originally in place is equal to 1.4, the swept area will be approximately the same as would have been obtained by injection of only one-half as much gas (0.70 pattern volumes) had the pattern been unfractured.

Fractures of the type shown in Figure 5 are indicated to be more efficient. A greater swept area may be obtained by injecting less gas than if the pattern were unfractured, or if the patterns were fractured similar to those shown in Figures 6, 7 and 8. To obtain a swept area of 80 percent, the gas processed divided by gas originally in place must be equal to approximately 0.80 to 0.98 for Figures 5, 6 and unfractured patterns, respectively. This sweep efficiency of 80 percent might not be achieved if a fracture of the type shown in Figures 7 and 8 had occurred.

Figure 11 shows the gas composition from the producing wells when cycling these various horizontally fractured patterns. The abscissa of Figure 11 shows the gas processed divided by gas originally in place. The ordinate shows the fractional composition of wet gas in the flow stream. The curve numbers correspond to patterns shown in the respective figure numbers. One hundred percent wet gas is expected to appear until the swept area of the reservoir is between 64 and 81 per-

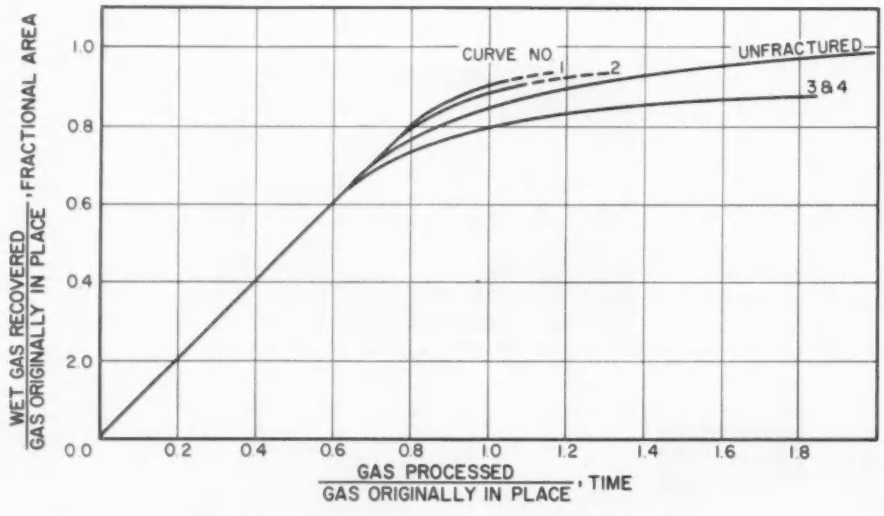

FIGURE 9—Cycling performance for conditions 1-4.

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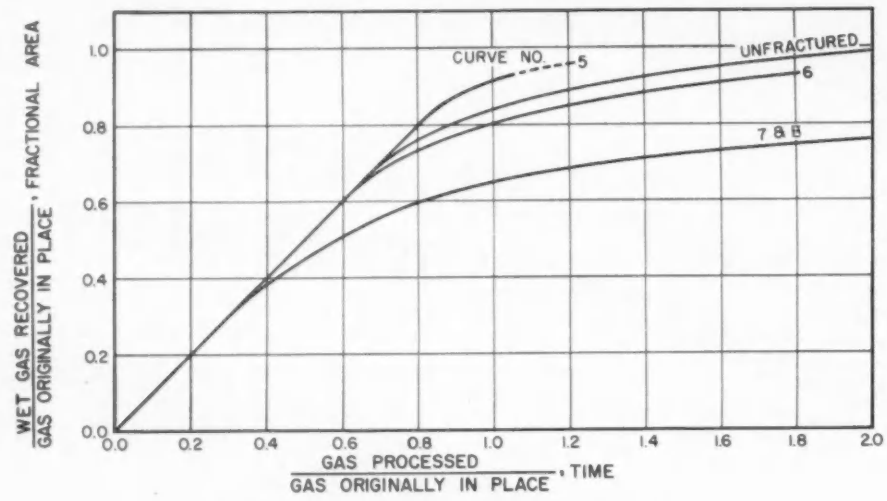
CURVE NO. 5
UNFRACTURED
6
7 & 8
WET GAS RECOVERED / GAS ORIGINALLY IN PLACE, FRACTIONAL AREA
GAS PROCESSED / GAS ORIGINALLY IN PLACE, TIME

FIGURE 10—Cycling performance for conditions 5-8.

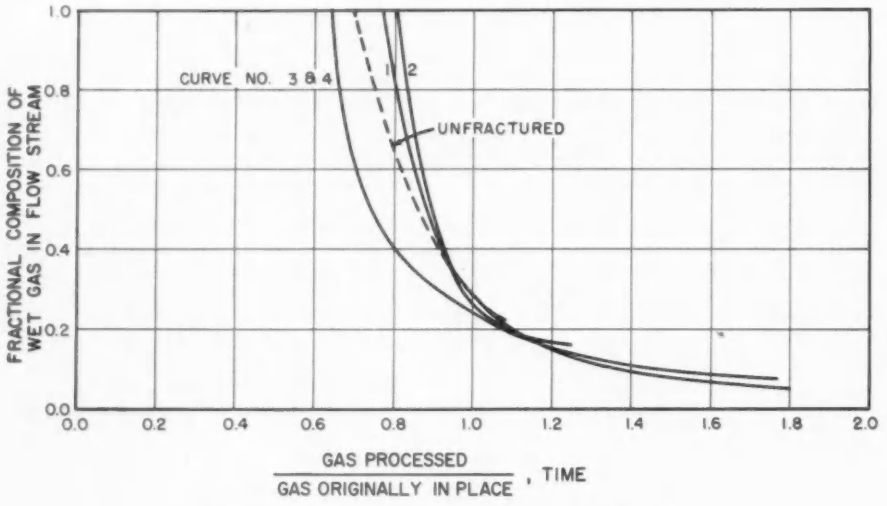

FIGURE 11—Cycle gas composition conditions 1-4.

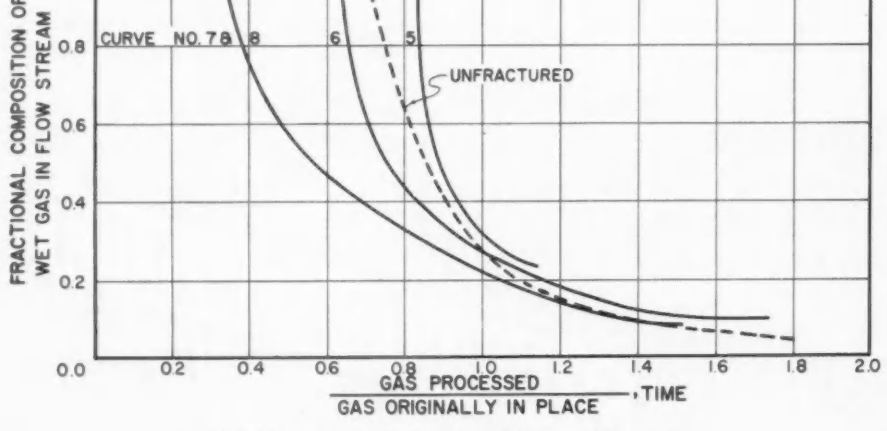

FIGURE 12—Cycling gas composition conditions 5-8.

cent. Beyond this amount the percent wet gas is expected to decrease very rapidly.

Sixty percent wet gas is expected to appear in the effluent when the gas processed divided by gas originally in place is 0.70, 0.82, 0.85 and 0.88 for the case of fractures shown in Figures 3 and 4, unfractured pattern, Figure 2 and Figure 1, respectively.

Approximately 20 percent wet gas may appear in the effluent for all patterns shown here when the gas processed divided by gas originally in place is near 1.1. If the cycling program were discontinued at this time, Figure 9 indicates that the swept areas may vary between 81 and 93 percent, depending on the type of fractures created.

The fractures shown in Figures 1 and 2 provide greater swept areas than the unfractured pattern or fractures of the type shown in Figures 3 and 4. Similar comparisons of swept areas and wet gas compositions may be made from this figure.

Figure 12 shows the composition of the produced gas when cycling a horizontally fractured thin reservoir having fractures of the type shown in Figures 5, 6, 7 and 8. The curve numbers correspond to the figure numbers. Approximately 100 percent wet gas will appear in the effluent until 33 to 84 percent of the pattern area has been processed, depending on the type of fracture created. Approximately 60 percent wet gas may appear in the flow stream when the gas processed divided by gas originally in place is near 0.48, 0.71, 0.81 and 0.86 for fractures of the type shown in Figures 7 and 8, 6, unfractured patterns and Figure 5, respectively. Approximately 20 percent wet gas may appear in the effluent when the gas processed divided by gas originally in place is between 1.0 and 1.2, depending on the type of fracture.

Referring to Figure 10, the swept area at this time may vary between 65 and 95 percent, depending on the type of fracture created. The fracture shown in Figure 5 is indicated to be the most effective of those shown here.

Water-Flooding Application. These data may be applied to water flooding provided the flood corresponds to the analog model described above.

Discussion and Conclusions. The creation of elliptical fractures at either the injection or production well may either increase or decrease the sweep efficiency which would be expected had no fractures been created. Elliptical fractures with the major axis perpendicular to flow may result in a sweep efficiency either more or less than the unfractured sweep efficiency, depending on the width of the minor

axis of the elliptical fracture. If the major axis of the elliptical fracture is parallel to flow, the sweep efficiencies are less than that which would occur had no fractures been created.

It may be possible to achieve large swept areas in an elliptically fractured reservoir, but to do so will probably require the injection of more gas or water. The magnitudes of these additional quantities of fluid are indicated to be from 10 to 100 percent, depending on the type of fracture existing and swept area desired. The water flooding or gas cycling program might be discontinued when the effluent reached a given water:oil ratio or percent wet gas.

In this case the creation of elliptical fractures may result in a swept area which would be either more or less than would occur had no fracture been created. It is suggested that studies be made to estimate the nature of the fractures prior to initiating the water flooding or gas cycling program to insure that the largest practical swept areas are achieved and that channelling is held to a minimum.

Part 2 When both input and output wells in a line-drive pattern are assumed to have elliptical fractures.

FOR THE PATTERNS studied the presence of an elliptical fracture at the input well and the output well may either increase or decrease the sweep efficiency from that achieved if the pattern is unfractured. When the major diameters of the ellipses were 33.8 percent of the well spacing and flooding was perpendicular to the major axis, a sweep efficiency of 73 percent was observed.

The unfractured sweep efficiency is near 70.2 percent. If the fractures are of very large size, the sweep efficiency may be less than that expected if no fractures were created. When the major diameters of the ellipses were 62.5 percent of the well spacing and flooding was perpendicular to the major axis, the sweep efficiency was near 65.8 percent.

The creation of elongated ellipses and flooding parallel to the major axis may result in very low sweep efficiencies in some instances. In one case studied a sweep efficiency of nearly 30 percent was observed. If the cycling program were discontinued when 20 percent wet gas appears in the flow stream, the swept areas may vary from near 68 to 90 percent, depending on the type of fracture created.

To achieve large swept areas in elliptically fractured reservoirs might require processing larger quantities of fluid than would be required had no fractures been created.

Fractured Reservoir Performance. Figure 13 shows an element of a line-drive pattern in which an elliptical fracture is assumed to exist at the input and output wells. The length of the pattern divided by the width of the pattern is equal to 1.5. The elliptical fractures are identical. The ellipses major axes are 33.8 percent of the distance between adjacent input wells. Cycling is conducted perpendicular to the major axes.

Figure 13 also shows the position of the dry gas at various times in the cycling program. The gas recovered divided by gas originally in place, the gas processed divided by gas originally in place, and the fractional composition of wet gas in the flow stream is shown on the figure. The position of the dry gas/wet gas interface is shown at four instances before break-through, at break-through, and three instances after break-through.

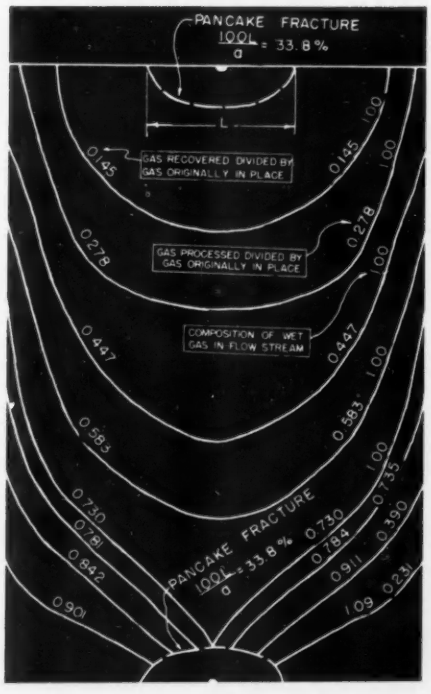

FIGURE 13

The first position shows the dry gas:wet gas interface when the gas recovered divided by gas originally in place is equal to 0.145. At this time the gas processed divided by gas originally in place is equal to 0.145 and the fractional composition of wet gas in the flow stream is equal to 1.00.

It will be noted that when break-through occurs, the gas recovered divided by gas originally in place is equal to 0.730, the gas processed divided by gas originally in place is equal to 0.730, and the fractional composition of wet gas in the flow stream is equal to 1.00. (Note: the unfractured sweep efficiency is near 70.2 percent).

After break-through, a swept area of 0.901 may be obtained if the gas processed divided by gas originally in place is equal to 1.09. At this time the fractional composition wet gas in the flow stream would be near 0.231.

Figure 14 shows the position of dry gas at various times when large elliptical fractures exist at the input and output wells. Here the major axes of the elliptical fractures are equal to 62.5 percent of the distance between adjacent input wells.

When the dry gas breaks through at the output well, the gas recovered divided by gas originally in place will be near 0.658, the gas processed divided by gas originally in place will be near 0.658, and fractional composition of wet gas in the flow stream will be near 1.00.

When the gas recovered divided by gas originally in place is near 0.809,

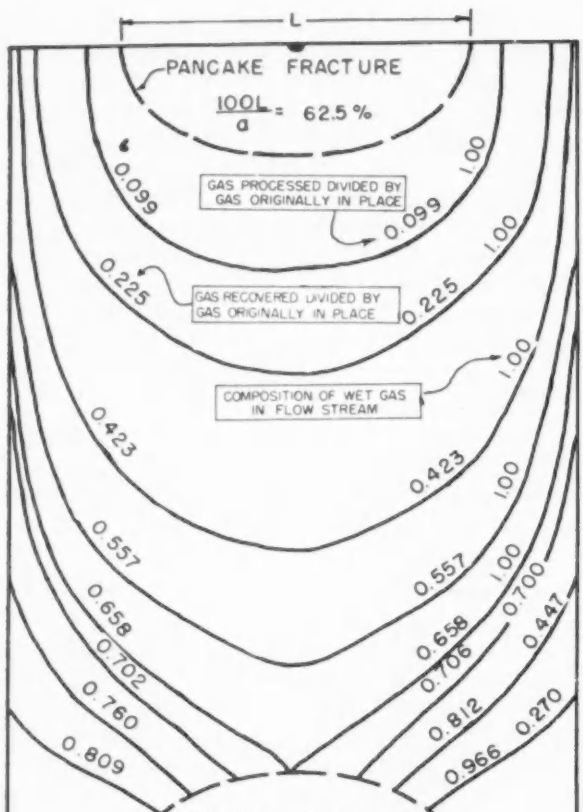

FIGURE 14

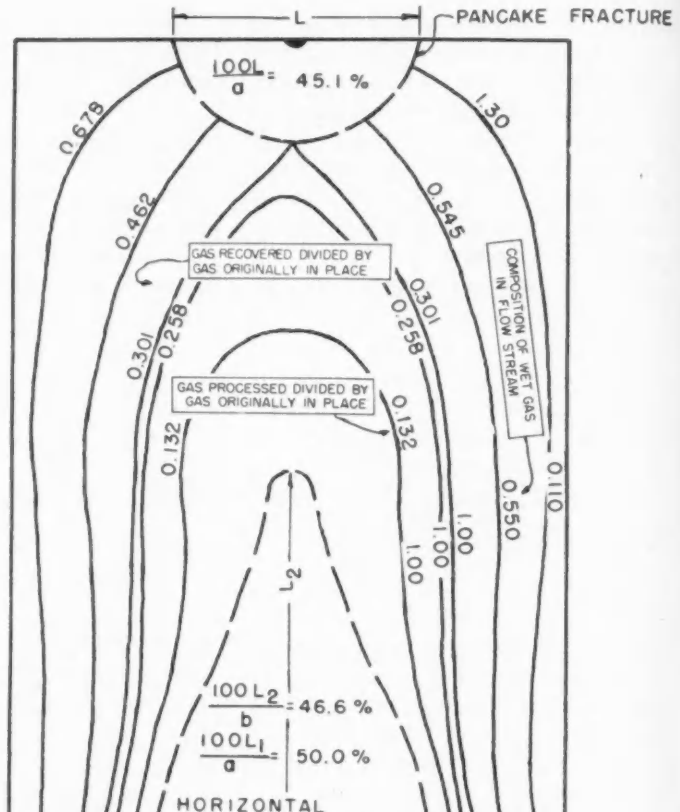

FIGURE 15

the gas processed divided by gas originally in place will be near 0.966, and the fractional composition of wet gas in the flow stream will be near 0.270.

By creating elliptical fractures of the proper size and shape, the sweep efficiency may be either larger or smaller than the unfractured sweep efficiency. Fractures of the type shown in Figure 13 resulted in a sweep efficiency in excess of the unfractured pattern. Fractures of the type shown in Figure 14 resulted in a sweep efficiency which was less than the unfractured sweep efficiency.

Figure 15 shows the position of dry gas at various times when an irregular shaped fracture existed at the input well and a circular fracture existed at the output well. It will be noted that the fracture at the input well extends 46.6 percent of the distance between input and output wells, and the width of the fracture is 50 percent of the distance between adjacent input wells.

The "pancake" fracture at the output well has a major axis 45.1 percent of the distance between adjacent output wells. The position of the dry gas is shown at two instances before breakthrough, at breakthrough, and two instances after breakthrough.

At the first instance shown the gas recovered divided by gas originally in place is equal to 0.132, the gas processed divided by gas originally in place is equal to 0.132, and the fractional composition of wet gas in the flow stream is equal to 1.00.

For this type pattern a large percentage of the flow enters the area near the tip of the fracture and proceeds across towards the output well. When break-through occurs, the gas recovered divided by gas originally in place is equal to 0.301. When the gas recovered divided by gas originally in place is equal to 0.678, the gas processed divided by gas originally in place is equal to 1.30, and the fractional composition of wet gas in the flow stream is near 0.110.

Figure 16 shows the cycling performance of the horizontally fractured thin reservoirs shown in Figures 13, 14 and 15. The abscissa shows the gas processed divided by gas originally in place which may also represent a time coordinate. The ordinate shows the wet gas recovered divided by gas originally in place which also represents the fractional area swept. Curves 1, 2, and 3 show the performance when cycling fractured patterns shown in Figures 13, 14, and 15, respectively. The curve marked "unfractured" shows the performance which is expected when the pattern is unfractured.

When the gas processed divided by gas originally in place is equal to one, the swept area may vary from near 0.61 to 0.88, depending on the type of fracture created. When the gas processed divided by gas originally in place is near 1.4, the swept area may vary from near 0.70 to 0.95, depending on the type of fracture. In order to achieve an 80 percent swept area, the gas processed divided by gas originally in place must be near 0.83, 0.88 and 0.94 for fractures of the type shown in Figure 13, the unfractured pattern, and Figure 14, respectively. If an 80 percent swept area could be achieved in cycling the pattern shown in Figure 15, it would occur when the gas processed divided by gas originally in place was 2.00 or greater.

Continued on Page 195

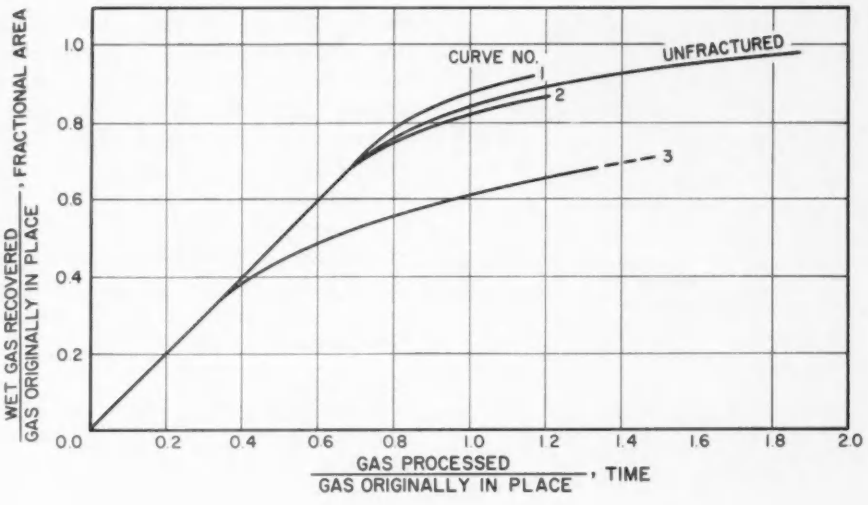

Figure 16

Figure 17 shows the effluent gas composition when cycling the various fractured patterns shown here. The abscissa shows the gas processed divided by gas originally in place, the ordinate shows the fractional composition of wet gas in the flow stream. Curves 1, 2, and 3 provide the gas composition when cycling fractured patterns like those shown in Figures 13, 14 and 15, respectively.

The dashed line on Figure 17 shows the unfractured pattern results. One hundred percent wet gas will appear in the effluent until the gas processed divided by gas originally in place is between 0.3 and 0.73, depending on the type of fracture existing. If no fractures were created, the effluent would remain 100 percent wet gas until 70.2 percent of the pattern were swept. The above are indicated for uniform homogeneous reservoirs.

When the gas processed divided by gas originally in place is equal to 0.8, the effluent gas composition may vary between 30 and 65 percent wet gas, depending on the type of fracture. Approximately 20 percent wet gas is expected in the effluent when the gas processed divided by gas originally in place is near 1.1 to 1.3. If cycling were discontinued when the wet gas approached 20 percent, the gas processed divided by gas originally in place would be near 1.1, 1.15, 1.1 and 1.3 for the unfractured pattern and Patterns 1, 2, and 3, respectively. The swept areas would then correspond to 87, 92, 85 and 68 percent, respectively. If cycling is discontinued at a given percent wet gas in the flow stream, the horizontally fractured pattern may result in a large swept area at abandonment, depending on the type of fracture existing.

The creation of fractures will result in an increase in pattern conductivity. For a given imposed pressure differential, the injection rate may be several times greater than that which would exist if no fractures had been created.[1] This implies that if the process equipment were of sufficient capacity, it is possible to cycle the reservoir in a much shorter time. Although the gross return from the reservoir may be approximately the same, the rate of return from the fractured system could exceed the rate for the unfractured pattern. A detailed study would be required to determine the merits for each case.

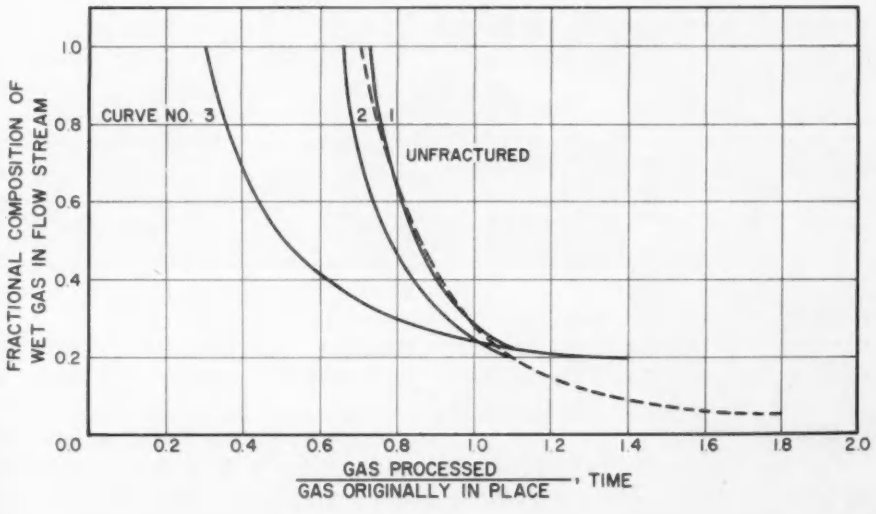

Figure 17

Discussion and Conclusions. When elliptical fractures exist at both the input and output wells, and flooding or cycling is conducted perpendicular to the major axes of the ellipses, the sweep efficiency may be greater than that which would exist had no fractures been created. If the elliptical fractures are of large size, the sweep efficiency may be less than that which would exist had no fractures been created.

The performance after breakthrough indicates that for certain small fractures the swept area may equal or exceed the unfractured pattern, depending on the type of fracture. In some instances the creation of an unfavorable fracture or the operation of the injection program so that flow is parallel to the major axis of the ellipses may result in a fairly poor cycling or water flooding performance; however, it is possible to achieve large swept areas provided sufficient fluid is processed.

A detailed study should be made of any fractured reservoir to determine the nature and extent of the fractures prior to initiating the flooding or cycling program. This is required if channelling is to be held to a minimum and large swept areas are to be achieved.

In applying the results presented here it is necessary that one refer to the analogy to ensure that flow in the actual reservoir conforms with that in the model. The data may or may not apply, depending on the variance existing between the model and the reservoir.

ACKNOWLEDGMENT

The authors wish to acknowledge the encouragement of Dr. George H. Fancher, Director, in conducting this study. Appreciation is expressed to the Texas Petroleum Research Committee for permission to publish the results.

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[1] Crawford, Paul B., and Collins, R. E., "Analysis of Flooding Horizontally Fractured Thin Reservoirs," Paper 346-G, AIME Annual Meeting, Petroleum Branch, New York, February, 1954.

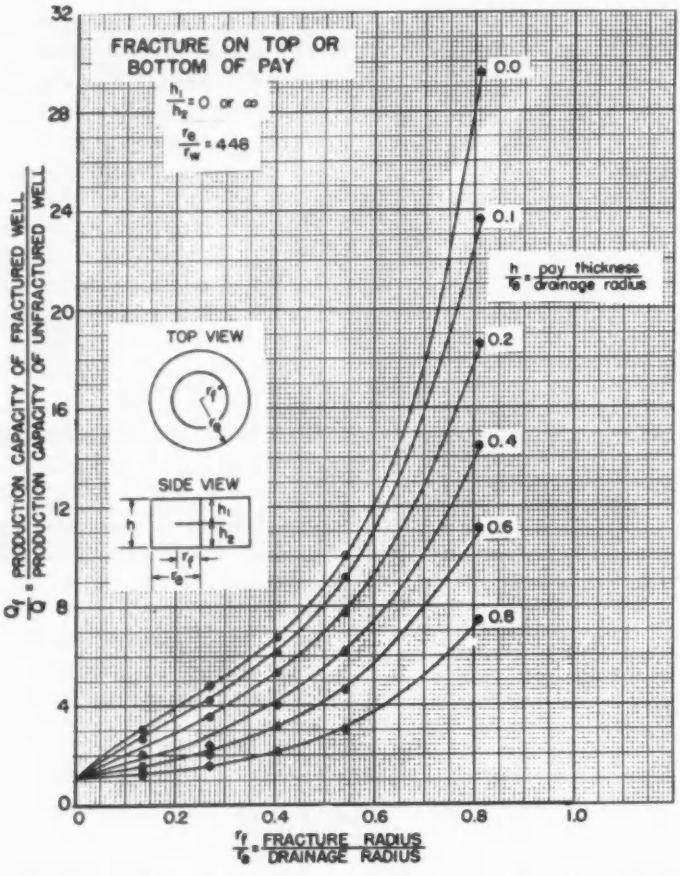

FIGURE 1—Effect of circular horizontal fractures on production capacity where fractures are placed at top or bottom.

Theory

Do Horizontal Fractures Affect Production Capacity?

Studies indicate center of pay in thick sections to be more responsive to fracturing.

By PAUL B. CRAWFORD, Assistant Director, and
BOBBY L. LANDRUM, Research Technologist,
Texas Petroleum Research Committee,
Texas A. & M. College Division, College Station, Texas

AN ELECTRICAL MODEL study has been made of the effect of horizontal fractures on the production capacity of fractured wells. For thin reservoirs it is shown that increases in production capacity by factors of 4 to 12 may be obtained if the radius of the fracture is between 0.2 and 0.6 the drainage radius. For thick reservoirs the increases in production capacity may be near 1.4 to 3.8 if the fractures are between the same radii as indicated above.

For thin reservoirs there appears to be little difference in production capacity whether the fracture is located at the top, bottom or center of the pay. However, for thick reservoirs and long fractures the center of the pay is indicated to be more responsive than other locations. One large pancake fracture is more effective for increasing the production capacity than three fractures with one-third the radius. A single horizontal fracture whose radius is 0.6 the drainage radius may result in an increase in production capacity by a factor near 6.

Three fractures whose radius is near 0.2 the drainage radius are indicated to result in an increase in production by a factor near 3.5. Inclined circular fractures are indicated to be slightly less effective than horizontal fractures of the same radius. Elliptical fractures produce approximately the same effect on the production capacity as circular horizontal fractures with the same radius as the average radius of the ellipse.

Commercial reservoir fracturing techniques are believed to result in the creation of vertical, horizontal and perhaps inclined fractures, depending on the nature of the formation fractured and the fracturing process applied. The creation of fractures normally results in an increase in the production capacity of the well. Qualitatively, the production capacity is believed to increase as the size of the fracture increases. Very little quantitative information is known about either horizontal or inclined fractures; consequently, a purpose of this study was to obtain quantitative data on the effect of horizontal and inclined fractures on the production capacity of a well.

The fractures studied were those which originate at the well and extend out into the reservoir. Circular and elliptical fractures symmetrically located about the well were considered. Few commercial fracturing applications will possibly result in such simple symmetrical patterns, but the results from the study may aid in interpreting certain results experienced in the field, or guiding proposed fracturing applications.

Analysis. An electrical analog model was used in making the study. A circular tank 22 inches in diameter and approximately 18 inches high was constructed with a sheet of copper forming the wall and paraffin wax the bottom. See inset of Figure 1. A

AXELSON PICTORIAL

PULSE RATE. A doctor checks heart beat by feeling a patient's pulse. Jerry Caldwell, Pumper for Tidewater Associated Oil Company at Talco, Texas, can tell how his wells are pumping simply by feeling the vibration on the polished rod. Recently, *an Axelson Volu-Max pump with a 1¼" bore x 7 ft. length was installed in this well* (L. D. Wilson #2). It pumps 441 BPD of fluid from 2,900 feet netting 30 barrels of 18 gravity oil. Former rate was 351 BPD and 16 barrels of oil. When your wet wells require greater gross production at the same cycle rate, try an Axelson Volu-Max.

BIRD WATCHER. Jerry Caldwell (see above) raises quail for a hobby. He has over 200 which bring an average price of $2 a bird. He is the empty-handed quail hunter's best friend. Jerry says his birds have one thing in common with Axelson oilwell pumping products—*they don't require much care.*

AXELSON USI

HYDRAX. Here on a stripper well near Kilgore, Texas, is a typical Axelson Hydrax hydraulic pumping unit. Jud Hemperly, Production Foreman for F. A. Fuller Company, is well pleased with the installation — says that *Hydrax units are kind to rod strings.* An Axelson RLA Rod Liner Type Pump, 2 x 1¼ x 9 feet, produces 32 gravity oil from 3,600 feet. Together, the pump and Hydrax pumping unit make an unbeatable combination for low-cost mechanical lift.

AXELSON PICTORIAL

MATERNITY WARD. The Jones & Laughlin repair shop in Oklahoma City is a clinic for ailing pumps and a maternity ward for new ones. Watching the birth of a new Axelson deep-well plunger pump (left to right): O. W. Shepherd, J & L Store Manager; John Rogers, Repairman (see below); Charles Cawthon, Axelson factory representative; and Chet Kyle, Axelson District Manager. Pumps that have been in service for many years are brought back to their original efficiency simply by replacing worn parts, such as liners, plungers, balls and seats, cages and tubes.

ON STILTS. In Grady County, Oklahoma, this Axelson Long Stroke hydraulic pumping unit perches on a unique steel platform to keep it above the water line during flood seasons. It pumps 39 gravity oil from 9,200 feet in Magnolia Petroleum Company's Virgil Daugherty No. 1. The normal length of pumping stroke in an Axelson unit is 25 ft. Pumping rate is 4 to 6½ strokes per minute. *A conventional beam pumping unit with a 6 ft. polished rod travel would have to operate at 25 strokes per minute to match an Axelson 25 ft. polished rod travel at 6 strokes per minute.* By slowing down the pumping rate, Axelson units reduce wear and tear on subsurface pump and rods and cause less turbulence at well bottom.

EXPERT. Making up a new Axelson subsurface pump is John Rogers, Jones & Laughlin pump repairman. *John is reputedly one of the top pump men in the industry.* He was born in Wilburton, Oklahoma, is a graduate of Okmulgee Business College and is a CPA. John also plays a creditable french harp and guitar. He has been with J & L for 12 years, taking excellent care of Axelson pump customers.

MEN OF PRODUCTION. Meet Atlantic Refining Company's well-pulling crew with an excellent safety record and a soft spot in their hearts for Axelson production equipment. (Top) O. A. "Doc" Lambert, Head Well Puller; (Bottom, left to right) B. M. Battles, Gene Larrimore, Hilton Murray. They keep wells producing with Axelson pumps in the Kilgore, Texas, fields.

CAMERA! ACTION! This is Atlantic Refining's well gang in action (see above) stripping the Calvin Young A No. 5 in Rusk County, Texas, to locate a tubing leak. *An Axelson tubing liner pump has been producing this well for many months and went back down the well without requiring service when remedial work was finished.* This area (Longview-Kilgore) is serviced by Dick Baucum and Bill Norman, Axelson Representatives working out of Longview, Texas, and by the Jones & Laughlin supply store in Kilgore.

GOOD WORD. Dusty Dillon (left), District Production Foreman for Atlantic Refining Company in East Texas, looks over well-pulling operation (above) while Doc Lambert lifts another stand of pipe. Like many another production head, Dusty has a good word for Axelson plunger pumps and sucker rods.

AXELSON

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HOT ROD. Slippage in subsurface pumps is frequently caused by wear on the outside surfaces of plungers. To give Axelson plungers long-wearing quality, surfaces are flame-hardened. Mike Sanceri, Axelson Rockwell operator, makes a hardness test on an Axelson plunger to make certain that heat treatment is uniform and to specifications. In spare time, Mike builds hot rods. His latest (a Model A frame and body with a '52 full-race Lincoln engine) took a fourth in its class at Bonnieville doing 164 MPH.

MIKE SIDE. Axelson plungers are made to fit as snugly in pump liners as pistons in a compressor cylinder. *Fits are within .001 inch.* Special API gauges (manufactured by Axelson) are used to check these close tolerances. Axelson also makes chromium plated plungers in a choice of three thicknesses of chromium. (.012, .021, .030 on diameter) for greater resistance to wear. Whatever the well condition—abrasion, corrosion, high water cut, etc. — Axelson plungers withstand the gaff.

NEWEST. Jones & Laughlin employees gather around the new J & L service truck in front of the Lindsay, Oklahoma store, *the newest addition to J & L's network of 91 supply stores in the United States and Canada.* (l. to r.) J. K. Guinn, salesman; L. R. Roberts, district sales manager; B. L. Parker, pump repairman; Bill Woodward, salesman; Karl Modenbach, store man; Dick Bayless, salesman; R. L. Parks, store man; D. H. Saltzman, store manager. Jones & Laughlin is distributor for Axelson production equipment.

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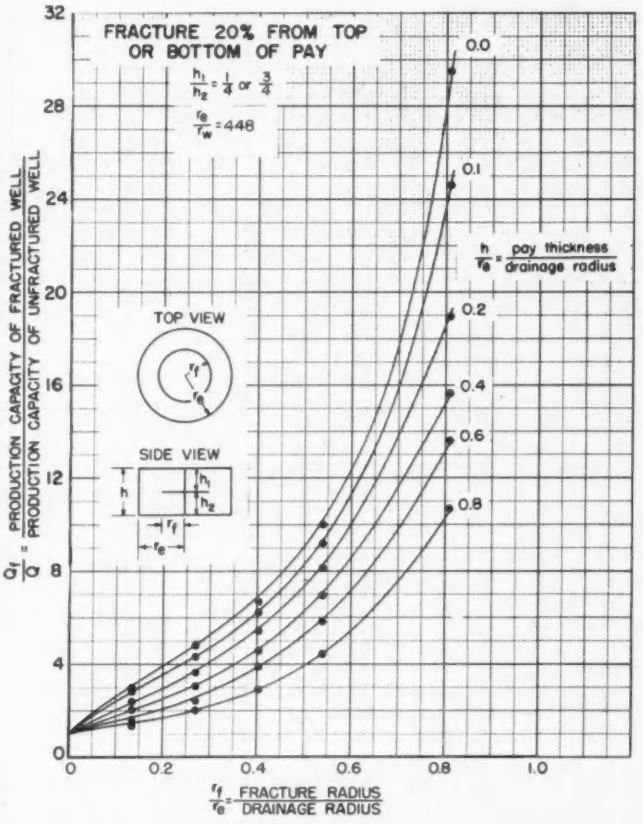

FIGURE 2—Effect of circular horizontal fractures on production capacity where fractures are 20 percent from top or bottom of pay zone.

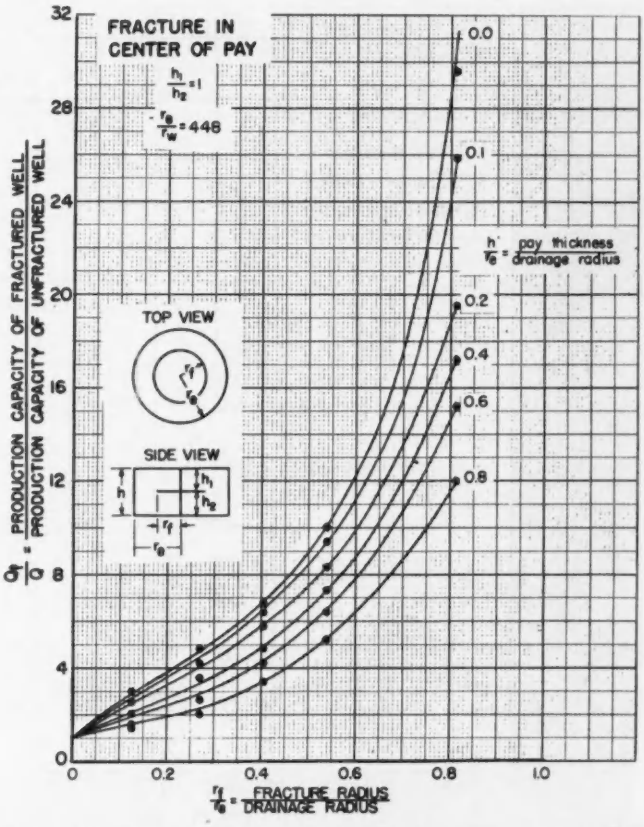

FIGURE 3—Effect of circular horizontal fractures on production capacity where fractures are in center of pay zone.

single wire electrode was placed in the center of the tank. The tank was partially filled with a dilute salt solution which served as the conducting medium. This electrical system simulates a single well in the center of a uniform homogeneous circular reservoir producing at steady state conditions.

Wilsey and Bearden presented information on unsteady phenomena.[1] Circular or pancake fractures were simulated by copper disks fabricated from sheeting. The copper disks were attached to the wire well. Fractures of various configurations, elevations and inclinations were studied by changing copper disks.

The effect of pay thickness was studied by varying the depth of the salt solution. The data obtained from this model indicate the effect of fractures of high permeability on the production capacity. The data apply to an actual reservoir only in such proportion as the flow in the reservoir conforms to the flow in the model.

Effect of Horizontal Fractures on Production Capacity. Figure 1 shows the effect of circular horizontal fractures on the production capacity when the fracture is located on the top or bottom of the pay. The data were obtained in a reservoir in which the drainage radius divided by the radius of the well was equal to 448. The abscissa shows the value of the fracture radius divided by the drainage radius. The ordinate shows the production capacity of the fractured well divided by the production capacity of the unfractured well. The parameter shown on the figure is pay thickness divided by the drainage radius.

The upper curve shows the increase in production capacity which may be expected when a very thin pay is fractured with a horizontal circular pancake fracture. If a fracture whose radius is 0.2 of the drainage radius is created an increase in production capacity by factor near 4 may be expected. If the fracture extends to 0.4 of the drainage radius the production capacity may be expected to increase by a factor near 6.7.

A fracture whose radius is 0.6 of the drainage radius may be expected to result in an increase in production capacity by a factor near 12. If the average drainage radius is near 330 feet and the pay thickness is 33 feet the value of the pay thickness divided by the drainage radius would be 0.10. For this condition the second curve from the top in Figure 1 may apply. If the fracture radius is 0.2 the drainage radius (this would be 65 feet if the drainage radius were 330 feet) a production capacity increase of near 3.5 would be expected.

For fractures whose radii are near 0.4 the drainage radius an increase in production capacity near 6 may be expected. The lower curves in Figure 1 are applicable for very thick reservoirs. If a fracture of 0.2 the drainage radius occurs in a thick reservoir (pay thickness divided by the drainage radius is near 0.8) an increase in production capacity by a factor near 1.3 may be expected.

If the fracture radius is near 0.4 the drainage radius an increase in production capacity by a factor near 2 may be expected. The above data indicate that increases in production capacity by factors of from 2 to 10 may be expected in some reservoirs, but they will perhaps be more likely in the thinner pays. In order to achieve a substantial increase in the production capacity of clean wells it may be necessary to obtain fairly large fractures,

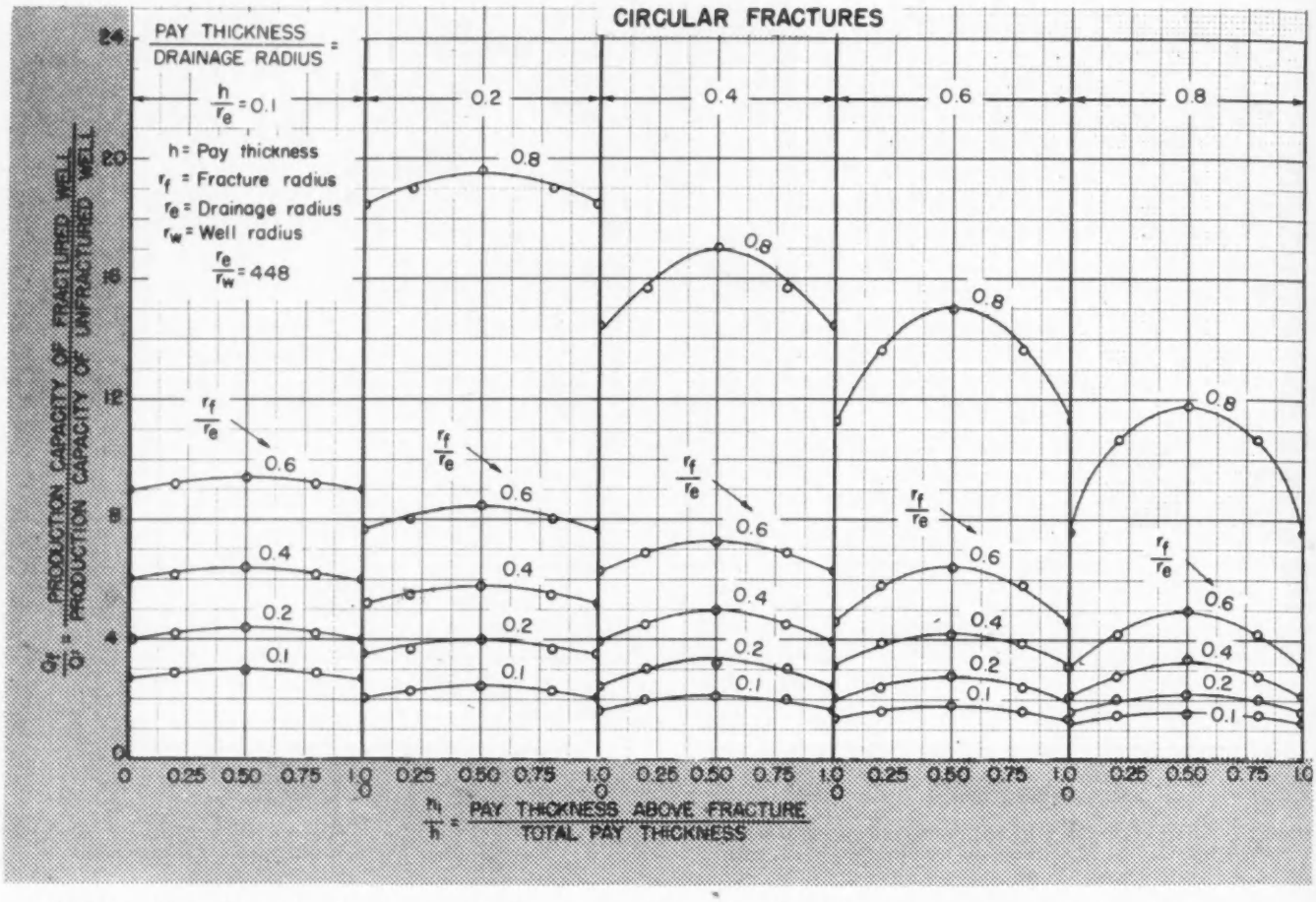

FIGURE 4—Effect of fracturing location on production capacity. Best results achieved from pay zone center especially in thin reservoirs.

and a decrease in water-flooding or gas cycling sweep efficiency may occur after achieving this increase in production capacity.

Figure 2 shows the effect of circular horizontal fractures on production capacity when the fractures were located 20 percent from the top or bottom of the pay. For this case the thickness of the reservoir above the fracture divided by the thickness below the fracture would be ¼ or ¾, depending on whether the fracture was located in the upper or lower portion of the pay.

The abscissa shows the fracture radius divided by the drainage radius. The ordinate shows the production capacity of the fractured well divided by the production capacity of the unfractured well. When a fracture is 0.2 the drainage radius an increase in production capacity by a factor near 4 may be expected for thin reservoirs. When the fracture radius is 0.4 the drainage radius a production capacity increase of 6.7 may be expected.

When the fracture radius divided by the drainage radius is near 0.6 a production capacity near 12.3 is to be expected. For thicker reservoirs, when the pay thickness divided by the drainage radius is near 0.1 and the fracture radius is near 0.2 the drainage radius, a production capacity increase near 3.6 is to be expected.

An increase in production capacity by a factor near 6.2 is to be expected if the radius of the fracture is 0.4 the drainage radius. For very thick reservoirs, that is, for the case in which the pay thickness divided by the drainage radius is near 0.8, a fracture whose radius is 0.2 the drainage radius may be expected to result in an increase in production capacity by a factor near 1.6.

If the fracture radius is near 0.4 the drainage radius the production capacity is expected to be near 2.8 times that of the unfractured well. In comparing Figure 1 and Figure 2 it will be noted that under certain conditions, that is, for very short fractures, there appears to be very little difference in the production capacity regardless of whether the fracture is located at the top of the pay or 20 percent from the top. From an electrical standpoint similar results occur when the fractures are at the bottom or 20 percent from the bottom of the reservoir. The most pronounced effect of fracture locations are indicated to occur for thick reservoirs and large fracture radii.

Figure 3 shows the effect of circular horizontal fractures on production capacity when the fractures were located in the center of the pay; the thickness of the pay above the fracture is equal to the thickness below the fracture.

Figure 3 shows that when the fracture radius is near 0.2 the drainage radius a production capacity increase by a factor near 4.0 may be expected for thin reservoirs. If the fracture radius is near 0.4 the drainage radius the production capacity increase may be expected to be near 6.8. If the fracture radius is near 0.6 the drainage radius the production capacity may be expected to be near 12.3.

For the case in which the pay thickness is 0.1 the drainage radius a fracture whose radius is 0.2 the drainage radius may be expected to result in an increase in production capacity by a factor near 3.6.

For fractures of 0.4 the drainage radius the production capacity increase may be expected to be near 6.8. If the fracture radius is near 0.6 the

drainage radius the production capacity may be expected to be near 11.2.

For the case in which the pay thickness is 0.4 the drainage radius and the fracture radius is 0.2 the drainage radius the resulting increase in production capacity may be near 2.8.

For fractures of 0.4 the drainage radius the production capacity is expected to be near 4.9. Similar observations may be obtained for thicker pays.

The effect of fracture location on production capacity is shown in Figure 4. It was prepared to compare the results of Figures 1, 2 and 3. Figure 4 shows the expected results of locating the fracture at different elevations in the pay for five different pay thicknesses. These pay thicknesses divided by the drainage radius were 0.1, 0.2, 0.4, 0.6 and 0.8.

If the fracture is near 0.6 the drainage radius that a production capacity increase by a factor near 9 is expected to occur if the reservoir thickness divided by the drainage radius is near 0.1 and the fracture is located at either the top or the bottom of the pay. That is, $\frac{h_1}{h}$ is equal to 0 or 1.0. The center of the pay is indicated to be only slightly more responsive to fracturing if the pay thickness is thin and the fracture radius is small. A fracture in the center of the pay might give a production increase by a factor near 9.4 compared to 9 if the fracture were located at the top or bottom of the pay.

For thicker pays (pay thickness divided by the drainage radius near 0.2) a production capacity increase of near 7.7 is expected to result if the fracture radius divided by the drainage radius is 0.6, and the fracture is at the top or bottom of the pay. By locating the fracture in the center of the pay an increase in production capacity to near 8.4 is expected to occur.

A more pronounced effect of fracture location is indicated for the case of very thick reservoirs. This is shown by comparing the results of fracturing when the thickness of the reservoir divided by the drainage radius is near 0.8. For this case, if the radius of the fracture is 0.6 the drainage radius, a production capacity increase by a factor near 3 may be expected. If the fracture is located in the center of the pay an increase in production capacity by a factor near 4.8 may be expected. This would be approximately a 50 percent increase by locating the fracture at the most responsive elevation. For longer fractures, that is, for fractures 0.8 the drainage radius, a more pronounced effect of fracture location is obtained.

Part 2 How single and multiple fractures, pay thickness, fracture and fracture shape affect well production capacity.

THE EFFECT of multiple horizontal fractures on production capacity is shown in Figure 5. It may be possible in some reservoirs to obtain one long fracture whose radius is near 0.6 the drainage radius or to obtain three fractures whose radii are near 0.2 the drainage radius. Figure 5 was prepared to show comparisons of effectiveness of fracture combinations of this type. This figure shows the effect of multiple horizontal fractures on production capacity. The reservoir is assumed to have a pay thickness divided by a drainage radius of near 0.4.

When more than one circular fracture exists the fractures are assumed to be symmetrically positioned in the pay. For the above case three short fractures ($0.2r_e$) would give a production increase by a factor of 3.5. One fracture three times as long ($0.6r_e$) would give an increase by a factor of 8.6. For this case one large fracture is more than twice as effective as three small fractures. Two fractures of $0.6r_e$ are expected to result in a production capacity increase of 9.8. If four fractures exist the production capacity is expected to be near 10, and if it were possible to ream the well to 0.6 the drainage radius the increase in production capacity would be expected to approach 12.0.

For shorter fractures, that is, those near 0.4 the drainage radius, one cir-

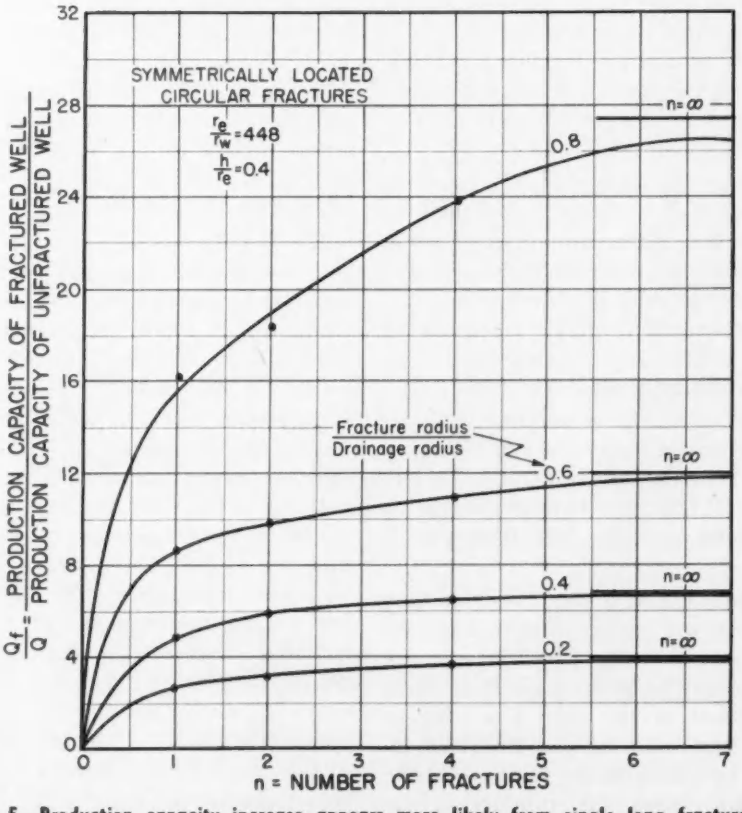

FIGURE 5—Production capacity increase appears more likely from single long fractures than multiple short ones.

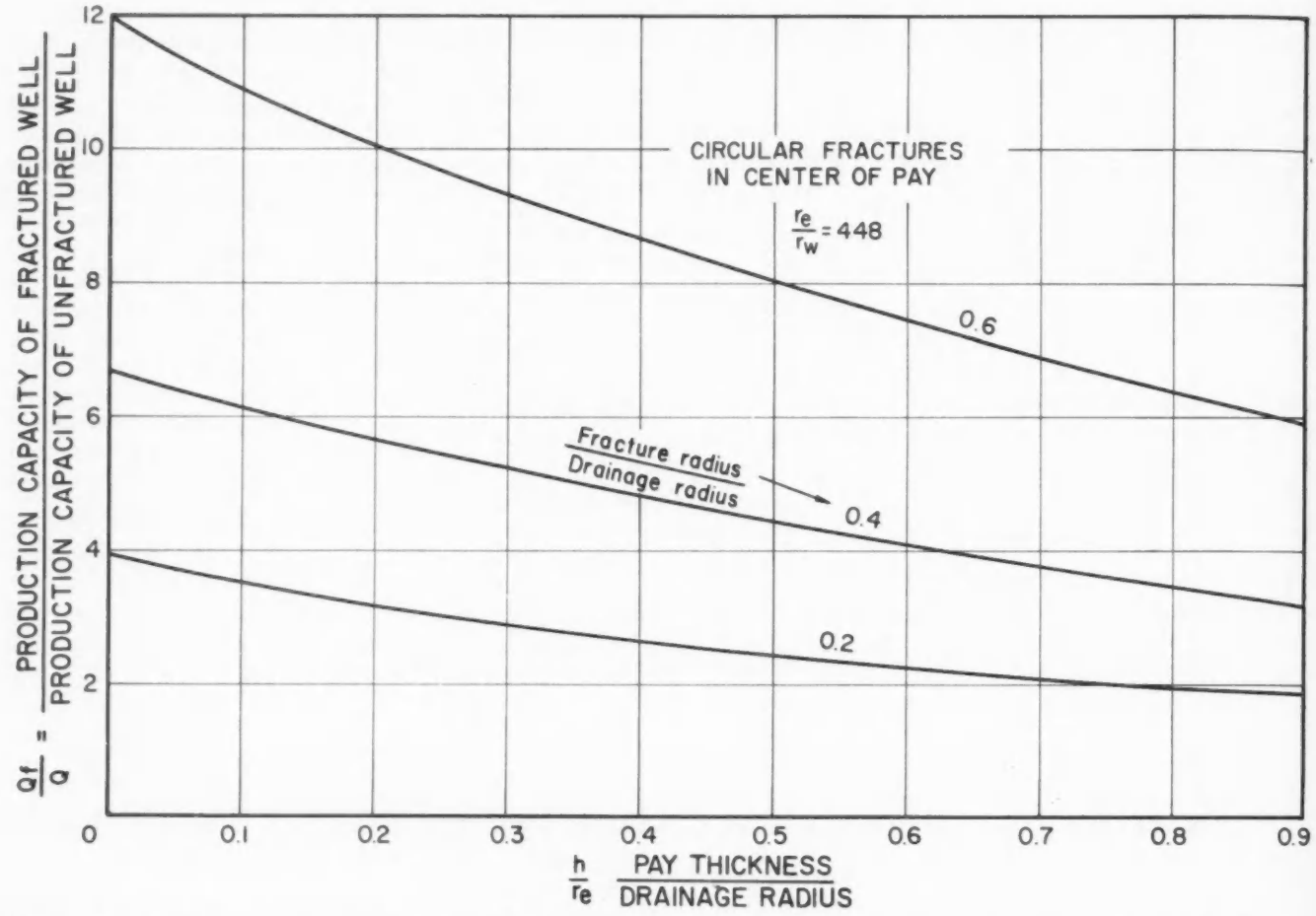

FIGURE 6—The effectiveness of a single fracture located at the center of a reservoir is expected to decrease as the reservoir thickness increases.

cular horizontal fracture may be expected to result in an increase in production capacity by a factor near 4.7. If two horizontal fractures of this same radius exist, the resulting increase in production capacity is expected to be near 5.8.

If four fractures exist the production capacity increase is expected to be near 6.3. If the primary objective is to achieve an increase in production capacity it will perhaps result in greater benefit if efforts are made to obtain single long fractures in preference to multiple short fractures.

This may be true only for uniform homogeneous reservoirs producing at steady state conditions. Stratified reservoirs will require a careful analysis to determine optimum fracturing procedures.

Figure 6 shows the effect of pay thickness on the production capacity of fractured wells. The fractures are assumed to be circular and located in the center of the pay. The abscissa shows the value of pay thickness divided by the drainage radius, and the ordinate shows the production capacity of the fractured well divided by the production capacity of the unfractured well. If the fracture radius is 0.2 of the drainage radius, increases in production capacity by factors of 3.9, 3.5, 3.1, 2.6 and 2.0 may be expected for reservoirs whose pay thicknesses divided by drainage radii are near 0, 0.1, 0.2, 0.4 and 0.8 respectively.

If the fracture were 0.4 the drainage radius, increases in production capacity by factors near 6.6, 6.1, 5.7, 4.8 and 3.5 would be expected for reservoirs of the cited thickness. In reviewing Figure 6 the effectiveness of a single fracture located in the center of a reservoir is expected to decrease as the thickness of the reservoir increases. This decrease is a decrease in the percentage of the original production rate, and it should be remembered that, other things being equal, the production from a reservoir is directly proportional to the pay thickness. Consequently, it may be shown that if a reservoir whose pay thickness divided by drainage radius is near 0.1 were fractured to a radius of 0.2 the drainage radius the increase in production capacity would be near 3.5. If a reservoir twice as thick were fractured to the same radius the increase in production capacity would be near 3.1

However, before fracturing the thicker pay would be expected to produce twice as fast as the thinner pay. Consequently, after fracturing the rates of production from the two pays would be of the order 3.5 and 6.2 for the thin and thick reservoirs, respectively. Similar comparisons may be made for fractures of other radii and reservoirs of other pay thicknesses.

It is believed that fractures may follow the planes of least resistance. In some reservoirs this may result in the fractures being inclined several degrees to the well. For such cases it may be desired to know the effect of fracture inclination on the production capacity.

Figure 7 shows the results of a study of the effect of fracture inclination on production capacity. Data were obtained with circular fractures in a reservoir whose thickness divided by the drainage radius was equal to 0.5. The thickness of the pay above the

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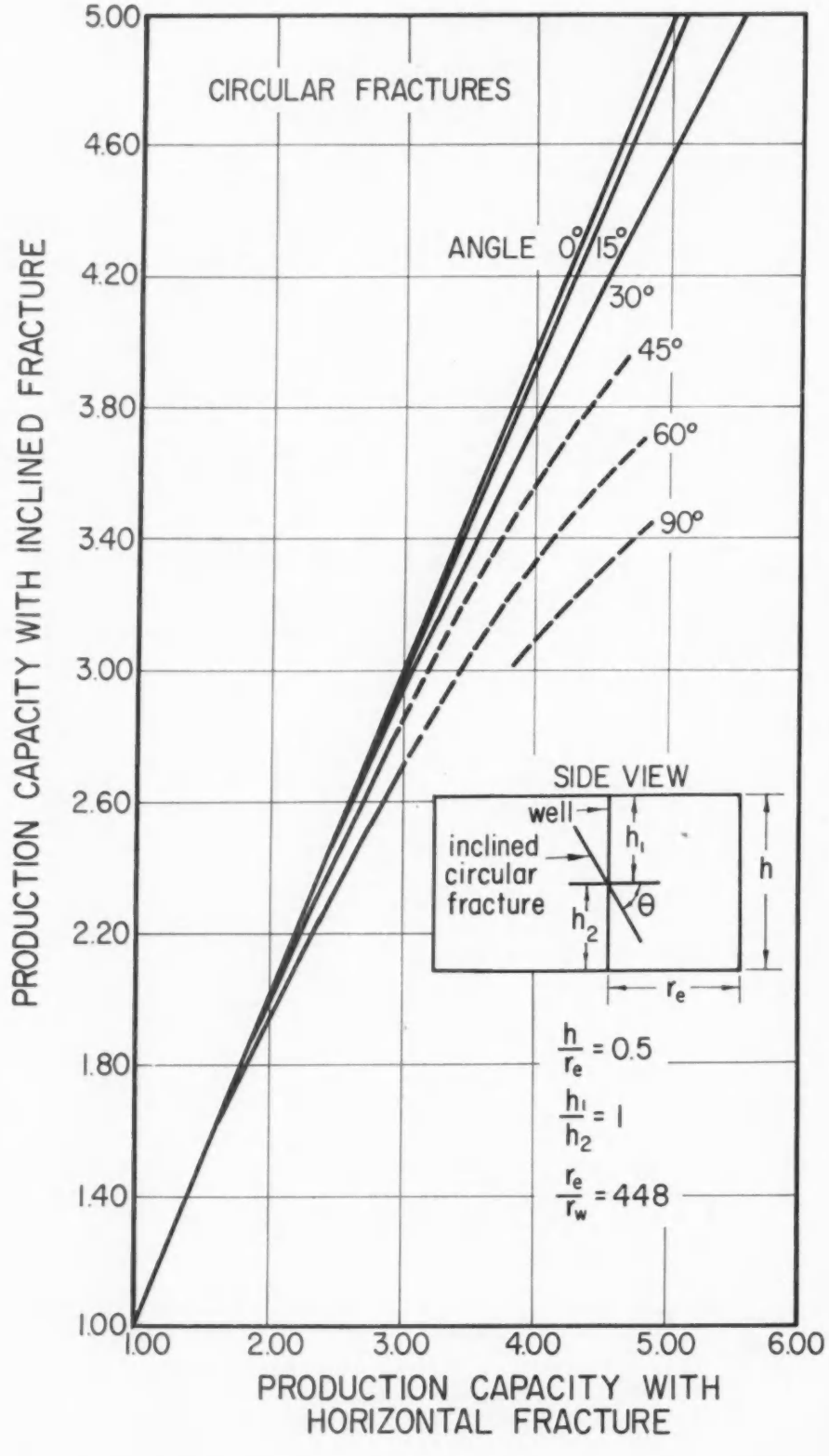

FIGURE 7—The effectiveness of the fracture to increase production decreases as the angle of inclination increases.

fracture divided by the thickness below is equal to 1.0, that is, the fracture occurred in the center of the pay. In securing the experimental data the circular fracture (copper disk) was tilted at various angles and the resulting production capacity was measured and compared with the production capacity of the unfractured system.

The abscissa of Figure 7 shows the production capacity with a circular horizontal fracture. The ordinate shows the production capacity with the inclined fracture. If the production capacity with the horizontal fracture is near 2.0, the production capacity with the fracture inclined from 0 to 15 degrees is expected to range from 1.9 to 2.0.

If a production capacity of near 4 would be expected to be observed with a circular horizontal fracture, then a production capacity of near 3.75 would be expected to occur if the fracture were inclined 30 degrees. If the fracture were inclined 45 degrees, a resulting production capacity near 3.6 would be observed, and if the fracture were inclined at approximately 90 degrees, resulting in a vertical fracture, the production capacity increase would be expected to be near 3.1.

The effectiveness of the fracture to increase production decreases as the angle of inclination increases. These data were obtained for a uniform, homogeneous reservoir producing at steady state conditions. It seems probable that flow in an actual reservoir may not be identical to flow in the model and that other results may be obtained in some reservoirs, especially those in which stratification exists.

Studies were made of the effect of elliptical horizontal fractures on production capacity. For the particular pattern studied the reservoir thickness divided by the drainage radius was near 1.0, and the elliptical fractures were located in the center of the pay. The elliptical horizontal fractures were simulated by copper disks cut to the shape of the desired ellipse, and attached to the wire well electrode. The ellipses were prepared so that the sum of the minor axis and major axis divided by four was equal to 0.4 the drainage radius. The abscissa shown in Figure 8 shows the value of the short radius of the ellipse divided by the long radius. The ordinate shows the production capacity with the elliptical fractures divided by the production capacity with a circular fracture whose radius was equal to 0.4 the drainage radius. For the elliptical fracture when the short radius divided by the long radius is near 0.8 the resulting production capacity is approximately the same as that which would be observed if a circular fracture were present.

If the short radius divided by the long radius of the ellipse is near 0.2, the production capacity of the ellipti-

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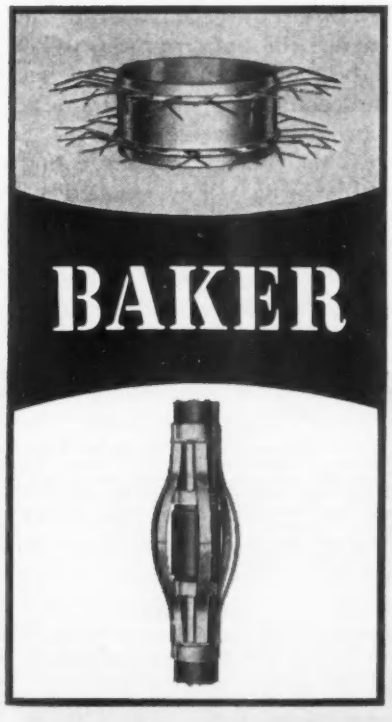

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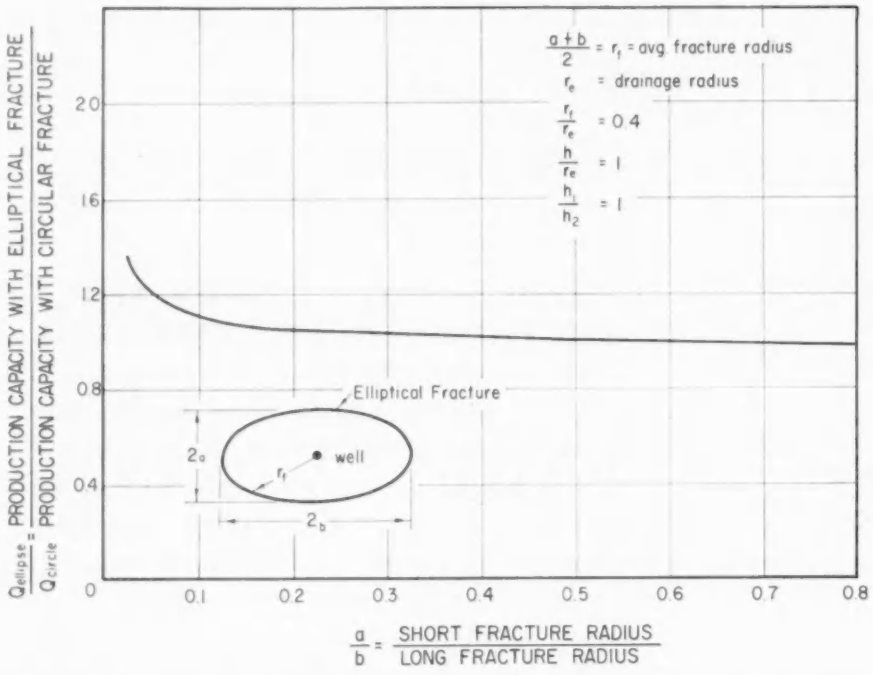

FIGURE 8—The effect of an elliptical fracture on production capacity appears very similar to the effect of a circular fracture whose radius is equal to the arithmetic average radius of ellipse.

cal fracture is expected to be near 1.06 times the production capacity which would be observed with the circular fracture. The curve is near 1.0 over a large range in variation of the shape of the ellipse. Consequently, it appears that the effect of an elliptical fracture on production capacity may be very similar to the effect of a circular fracture whose radius is equal to the arithmetic average radius of the ellipse.

Discussions and Conclusions. Electrical model studies have been made of the effect of various types of pancake fractures on the production capacity of clean wells. The data which are shown here apply to uniform and homogeneous reservoirs which are producing at steady state conditions. For these conditions, increases in production capacity by factors of 4 to 12 may be expected if the radius of the fracture is between 0.2 and 0.6 the drainage radius and the reservoir is very thin, that is, less than 15 feet for a ten acre well density.

For thicker pays, that is, those near 60 feet, increases in production capacity by factors of 3.5 to 9 may be expected if fractures of the radii indicated above are obtained. For thin reservoirs there appears to be little difference in the resulting production capacity regardless of whether the pancake fracture is located at either the top, center or bottom of the pay.

The center of the pay is indicated to be only slightly more responsive to fracturing than any other locations. The most pronounced effects of fracture location is expected to occur when large fractures are achieved or when a thick reservoir is fractured.

If the principal objective is to obtain a large increase in the production capacity of the well, the creation of a single large pancake fracture will possibly be more effective in achieving this objective than the creation of several fractures of small radius. The creation of an inclined circular fracture in a reservoir is indicated to have less effect on the production capacity of the well than if a horizontal circular fracture of the same radius were created. The inclination of the fracture between 0 and 30 degrees from the horizontal is expected to result in a decrease in production capacity of only one to ten percent, depending on the length of the fracture. The above conclusions were obtained for uniform homogeneous reservoirs and the possible benefits which may accrue from obtaining an inclined fracture which would cut beds of stratified pays may not conform to the observations obtained in the model.

The creation of elliptical fractures about a well is indicated to result in approximately the same increase in production capacity which would have been obtained had a circular horizontal fracture been created whose radius was equal to the average radius of the ellipse.

The data which are presented here are the steady state increases in production capacity which may be expected to occur if clean wells are fractured in reservoirs of uniform homogeneous media. If in actual practice the area near the well bore has been damaged so that the effective permeability near the well bore is less than the permeability in the outer areas the increase in production capacities which are indicated in the data presented here may be exceeded by several fold. In using these data to estimate fracture performance careful analysis should be made to determine that the flow in the reservoir conforms to the flow in the model.

These articles on fracturing theory were prepared exclusively for WORLD OIL by the Texas A. & M. Division of the Texas Petroleum Research Committee. This committee was established by joint resolution of the Board of Directors of A. & M. College, the Board of Regents of the University of Texas, and the Texas Railroad Commission in January of 1948. It was founded to combine the research facilities of the two schools and the vast store of knowledge of the Railroad Commission. The purpose of the committee is to seek methods of increasing total recovery from Texas oil fields through scientific means.

Funds for operating the committee are provided by A. & M. College, the University of Texas, and the Oil and Gas Conservation fund through the Texas Legislature. The director is Dr. George H. Faucher.

Those connected with the Committee include General Ernest O. Thompson, Chairman of Texas Railroad Commission; Dr. Logan Wilson, President of University of Texas, and Dr. M. F. Harrington, Chancellor of Texas A. & M. College.

The Texas Petroleum Research Committee has added much to the industry's knowledge through reserves surveys, engineering research, and recovery conferences. Some of this information is passed on here in the form of studies carried out on formation fracturing theory.

ACKNOWLEDGMENT

The authors wish to thank Dr. George H. Fancher, Director of Texas Petroleum Research Committe, for encouraging the work, and R. E. Collins, who assisted in securing preliminary data using smaller models. Henry Ince prepared the figures. Appreciation is expressed to the Texas Petroleum Research Committee for permission to publish the results.

REFERENCE

[1] Wilsey, L. E., and Bearden, W. G., "Reservoir Fracturing—A Method of Oil Recovery From Extremely Low Permeability Formations." Paper 317-G—Fall Meeting Petroleum Branch AIME, Dallas, October, 1953.

FIGURE 1—This photo was taken during the construction of the pipe line between Oruro and La Paz.

Why Bolivian Prospects Look Brighter

Domestic oil production now pegged at a potential of 12,000 barrels daily.

By J. E. RASSMUSS
Consulting Geologist, Lima, Peru

THE GEOGRAPHICAL location of Bolivia—surrounded as it is by major oil-consuming countries like Brazil, Argentina and Chile—is an attractive economical feature of the nation's petroleum industry. The prospects of Bolivian oil, its development, and its favorable geology are brighter in the setting of the new and more favorable oil law. (See page 307, April, 1956, WORLD OIL.)

Bolivia's prospects are brightened further by conditions existing in neighboring countries:

- Argentina, Brazil and Chile—no concession activity.
- Venezuela—no new concession granted yet.
- Colombia—new incentives offered in 1955 oil law, but development of eastern llanos region is both difficult and expensive.
- Peru—all prospective area is covered on the coast; Montaña of eastern Peru is closed until a scheduled auction. Besides, Montaña development requires major investments because of the jungle.

Why prospects are good . . .

Encouraging prospects in Boliva stem from:

- Significant production of new wells in Camiri field.
- Presence of several oil-bearing horizons.
- Thickness of the source beds.
- High grade of the Camiri crude.
- Volume of proven crude reserves in Camiri.

The latter indicate that the overthrusted subandean ridges may enclose large reservoirs.

Large and broader structures east at the Chaco border, where geophysical surveys have shown favorable structures, may offer a still large crude yield. Development of reserves in the order of 100-150 million barrels for supplying the pipe line to Arica at a rate of 50,000 barrels daily should be accomplished in a relatively short time and without excessive investments.

Transportation facilities from prospective areas in southeastern Bolivia to the Pacific, a distance of 800-900 miles, furnished by the new pipe line system should be economical in comparison with the greater movement of lower grade crude from the Middle

FIGURE 2—A drilling well in Camiri field.

FIGURE 3—This is the Bermejo River on the Argentine boundary looking south to the Standard Oil Company (New Jersey) Agua Blanca field.

East. Movement of the crude to Rosario, north of Buenos Aires, and in the center of Argentina's consumption area, would span a similar distance.

Oil development rapid . . .

Bolivia's oil development has been rapid in recent years. For many years, total national output amounted to about 1300 barrels daily. In 1953, however, production doubled, and in 1954 it amounted to more than 4500 barrels daily. The upturn continued in 1955 and reached about 8500 barrels per day during September. Total production for the first nine months of 1955 was 2,692,414 barrels. The present potential production is estimated at 12,000 barrels daily.

Increased production in Camiri, which yields more than 90 percent of Bolivia's total output, resulted from the discovery of a deeper horizon in the Devonian—the Sararenda sandstone at about 1000-1200 feet below the top of the Devonian.

Previous production had been limited to the two upper Devonian sands called the Upper Group and the Camiri sands of moderate thickness and yield. The Sararenda sandstone, about 100 feet thick, produces a considerably higher output in averaging about 500-600 barrels a day per well. The last well drilled in Camiri—C 71—produced 1400 barrels a day on test.

Reserves were further increased, too, by the discovery below the second overthrust of the Santa Anita sandstone of similar thickness. Well C 80 completed in this sandstone produced 920 barrels a day. In Wells C 65 and C 80, a third sandstone was discovered by an intermediate third overthrust.

Recently a new producing sand, No. 13, was discovered 20 feet below the Santa Anita, averaging about 25 feet in thickness and testing about 500 barrels daily in well 88, completed in December, 1955.

Average depth of Sararenda wells is about 3600 feet. In Guairuy's new well, G 6, three oilbearing sandstones were opened, yielding a total of about 1000 barrels a day from 1800 feet to 2300 feet.

Total proved crude reserves of the Camiri and Guairuy fields are estimated now at about 70 million barrels, 65 million for Camiri and 5 million barrels for Guairuy.

About midway between Camiri and Guairuy, in Itapirenda, another clos-

ure has been recognized below the Sararenda overthrust and an exploration well has been located. Also farther north, north of Parapeti river, a new favorable structure has been mapped.

Four rotary rigs are active in Camiri, two in Bermejo, one in Guairuy and four more have been acquired. Directional drilling has begun to speed up completions and to save cost of building roads on the deeply dissected high cliffs of the ridge. Twenty-five wells were flowing in Camiri out of a total of 35 producers at year's end.

Drilling has been suspended in Sanandita, awaiting arrival of a new rig for deeper drilling. Consequently, Sanandita field output amounted to only 145-150 barrels a day from old wells.

In Bermejo field, discovery on the second dome by the Toro well, which produced 450 barrels a day, substantially boosted the field's reserves. Bermejo production in 1954 amounted to about 200 barrels a day total.

Exports mount . . .

Thus, Bolivia's increasing crude production not only fulfilled domestic demand of about 4000 barrels a day but also permitted increasing amounts of export oil for neighboring countries.

Export of crude to Argentina is scheduled to reach 5000 barrels daily for a year. Other export operations include:

- Exporting of gasoline to Antofagasta in a barter pact for Chilean steel.
- Gasoline and kerosine is being shipped to Brazil on the new railway to Puerto Suarez and Corumba.

In addition, nearing conclusion are negotiations with Peru for supplying products to its southern markets of Puno, Juliaca and Cuzco by the new pipe line to La Paz. Further negotiations with Paraguay are pending.

In the McCarthy concession, the only foreign concession in operation thus far, three wells have been drilled. The first produced considerable gas, the second about 100 barrels daily of oil from 3140 feet, and the third was suspended because of a fishing job. A fourth well has been spudded, and drilling was expected to get under way after financing arrangements were worked out by Keljican Commercial Corporation of New York.

New pipe line system . . .

Development of Bolivia's oil potential has been facilitated further by the new pipe line system. To the south the 158-mile, 6⅝-inch pipe line to Yacuiba, on the Argentine border, was completed in April, 1955, and has a capacity of 18,000 barrels per day. The line connects in Pocitos with the Argentine pipe line being built to Embarcacion, from whence the railway to Formosa, on the Paraguay river, permits movement to the consuming centers of Argentina and to Paraguay.

The 332-mile pipe line from Camiri to Cochabamba, built in 1949 and which connects with a 44-mile lateral pipe line to the Sucre refinery, has been extended to La Paz. This 6⅝-inch pipe line was scheduled to be put into operation early in 1956 after construction of three pump stations.

Construction of a 218-mile pipe line from Villa Aroma, where it connects with the Oruro-La Paz pipe line, to Arica will permit movement of 50,000 barrels of oil daily to the Pacific Ocean. The pipe line to Charana will be of 10¾-inch diameter pipe, and 8⅝-inch on the descent to Arica. This line will be supplemented by another 10¾-inch pipe line from Villa Aroma to Oruro-Sucre-Tapirani to move 50,000 barrels of oil daily for export to Arica.

In the meantime, capacity of the pipe line to Arica will be restricted to about 7000 barrels a day.

Another important factor in facilitating Bolivia's oil development has been the completion of the railroad from Santa Cruz to Puerto Suarez, on the Brazilian frontier, where it connects at Corumba with the Brazilian railway to Sao Paulo and the terminal point of the 300-mile highway from Santa Cruz to Cochabamba.

The new railway from Yacuiba, on the Argentine border, to Santa Cruz, which has been built to Charagua, will facilitate movement of equipment and supplies over the connecting Argentine railways.

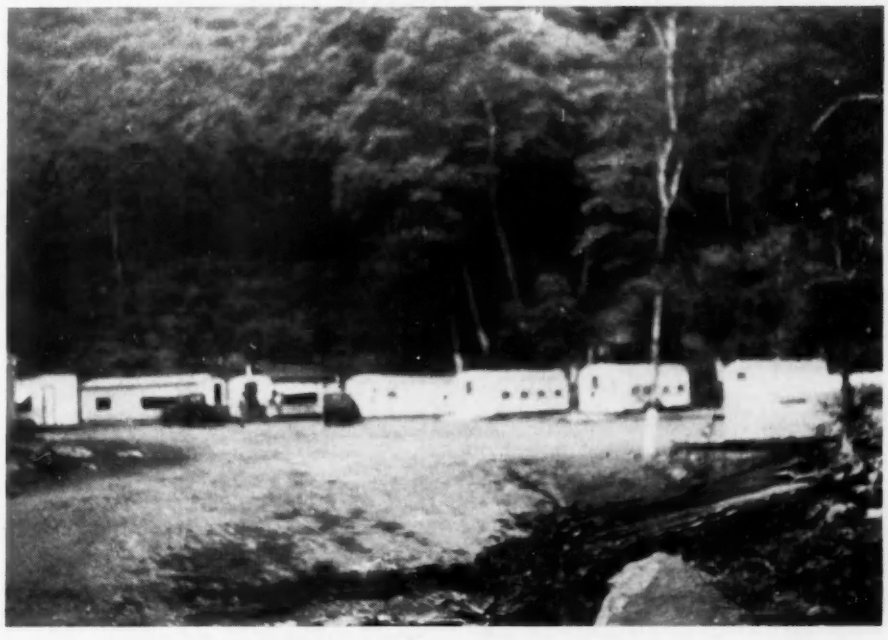

FIGURE 4—McCarthy's camp in Los Monos.

What about geology?

The subandean belt of Bolivia, which encompasses major oil accumulations, is built up by a series of marine Devonian beds covered by a sequence of almost exclusively continental deposits from Permotriassic to Tertiary age.

Devonian deposits comprise the petroliferous Monos shales, which attain a 10,000-foot thickness in the Santa Cruz region, and overlying Iquiri sandstones of 1300-1700 feet thick. Oil-sweating Monos shales emanating the pronounced odor of sweet crude can be observed on the new road from Santa Cruz to Samaipata. A large number of seepages is found on crests of Devonian anticlines or on overthrusts over the entire subandean zone of Bolivia.

Iquiri sandstones constitute the res-

ervoir rock in Camiri. Some shales of 80-100 feet exist on top as cap rock.

Devonian is overlain by the continental Gondwana formation, which encloses the glacial tillites of Permean age in its lower portion. The Tupambi sandstones on the bottom, 1300-1700 feet thick in the south and 700-800 feet thick in Santa Cruz region, offer an excellent reservoir rock because of their 21-22 percent porosity and high permeability.

These sandstones are found in the neighboring northern Argentina fields of Campo Duran and Madrejones. Recent wells in Madrejones reportedly produced 6000 barrels a day from the sandstones.

The Tupambi is overlain by the Tarija formation of similar thickness, which besides glacial tillites and clayish and silt deposits also contains sandy lenses which are oilbearing in the Bermejo and Sanandita fields.

The claygrits of the Tarija formation are newly overlain by sandstones of about 1700 feet thickness, called the Escarpment group because of steep escarpments, and by a more shaly section, called San Telmo beds, of similar thickness. These sections can be considered of Triassic age.

The Gondwana formation is overlain in the south unconformably by red sandstones of probably Lower Cretaceous age, covered by a marine limestone with chert about 150 feet thick. In Santa Cruz, the lower section is developed as yellowish sandstones of about 700 feet thickness. They may correspond to the Lower Cretaceous Agua Caliente sandstones of the Peruvian Montaña. The wide postnevadean transgression, which can be observed from Ecuador through the entire Peruvian Montaña, possibly is equivalent to the unconformable Lower Cretaceous sandstones covered by the limestone group of Bolivia.

The Mesozoic sequence of Bolivia's subandean belt is limited above by the unconformity of the Tertiary Chaco series of light and reddish sandstones and clays, corresponding to the tertiary "Red Beds" of Peru's and Ecuador's Oriente.

The structure of the proper subandean belt is determined by several ranges of steep anticlines, mostly overturned to the east and overthrusted. The large Camiri anticline, built up by Gondwana deposits, is overridden from the west by the overthrust of the Devonian Iquiri sandstones. New Camiri wells have proved that below Sararenda overthrust, which is exposed on the crest, a second overthrust repeats the oilbearing Devonian Sararenda sandstone in the Santa Anita sandstone. Too, it sometimes reappears as the intermediate sandstone.

These strong tectonic movements have squeezed the oil from the source bed of the underlying Monos shales and submitted it to a natural distillation, resulting in the accumulation of an extremely light crude in the abovenamed sandstones. Sararenda sandstone crude averages 52-54 gravity, and Santa Anita 56 gravity.

In Guairuy field about 16 miles south of Camiri, Well G 6, drilled in 1955, discovered the Guairuy sand which produced 300 barrels a day of 61-gravity crude. Also, below the second overthrust another new oilbearing sandstone was found to produce about 200 barrels daily.

Sanandita field, 125 miles south of Camiri, is on the Aguarague anticline. The anticline extends about 150 miles to northern Argentina, where the Tranquitas field is located. Aguarague anticline at Sanandita is composed of the Triassic Escarpment sandstone and San Telmo beds. The east flank is steep and the overlying Vitiyacu limestone and Tertiary Chaco beds are in vertical position. From the west, the San Telmo beds are covered on an overthrust, inclined 30-50 degrees west, by Permian glacial Tarija claygrits.

Tarija claygrits normally are overlain by the Escarpment sandstones, constituting the high cliff of the ridge crest. Crude is found in two principal horizons—at 1300-1700 feet and 2000-2300 feet—in Tarija formation sands. However, one well has produced 460,000 barrels of oil from a deeper block, separated by a second overthrust.

Therefore, a deeper test is proposed for the underlying Devonian of this block. Crude from Tarija sands in Sanandita averages 42-44 gravity.

To the east, the Monos anticline in the McCarthy concession is composed of the Monos shales in the center, overlain on the flanks by Gondwana and younger deposits. The crest of the anticline is cut by a vertical fault on which numerous seepages are exposed on the surface. Twelve miles long, the Monos anticline is more regular. But farther south it also shows an overthrust on the west flank. Even the Salada structure farther east on the Chaco border is cut by an overthrust. In general, the structures flatten to the east to the Chaco lowlands, and the Lomas anticline in Santa Cruz shows only a 15 degree dip on the flanks.

The southernmost field in Bolivia—the Bermejo field on the Argentine frontier which continues into Argentina as the Standard Oil Company (New Jersey) Agua Blanca field, is located on a 12-mile anticline, striking about north 25 degrees east.

The anticline is divided by the undulation of the crestline in three domes. It is composed of Cretaceous Candado sandstones below which—in the center of the two northern domes—the Tarija formation reaches the surface. The western flank is cut by an overthrust.

Crude is found in three horizons of sand lenses in the Tarija formation. One well has produced about 500,000 barrels from the underlying Tupambi sandstone. Therefore, new drilling is being directed toward development of the Tupambi sandstone. Tarija crude at Bermejo is 28-29 gravity, the only heavy crude in Bolivia. —**The End**

About the Author

DR. JUAN E. RASSMUSS, a consulting geologist of Lima, Peru, recently completed a survey of Bolivia's petroleum industry resources for the Yacimientos Petroliferos Fiscales Bolivianos, Bolivian government oil agency. Dr. Rassmuss has studied in Germany and Switzerland, He has worked many years in Argentina and later in Chile, Peru and Ecuador as an independent consulting geologist. Returning to Europe, he became manager and member of the board of a Rumanian oil company. When the Russians entered Rumania, Dr. Rassmuss returned to Peru, serving as petroleum consultant to the Peruvian government.

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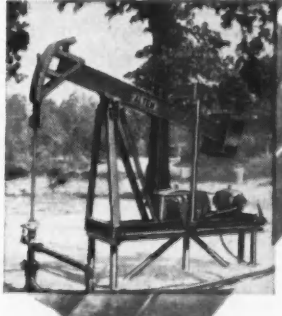

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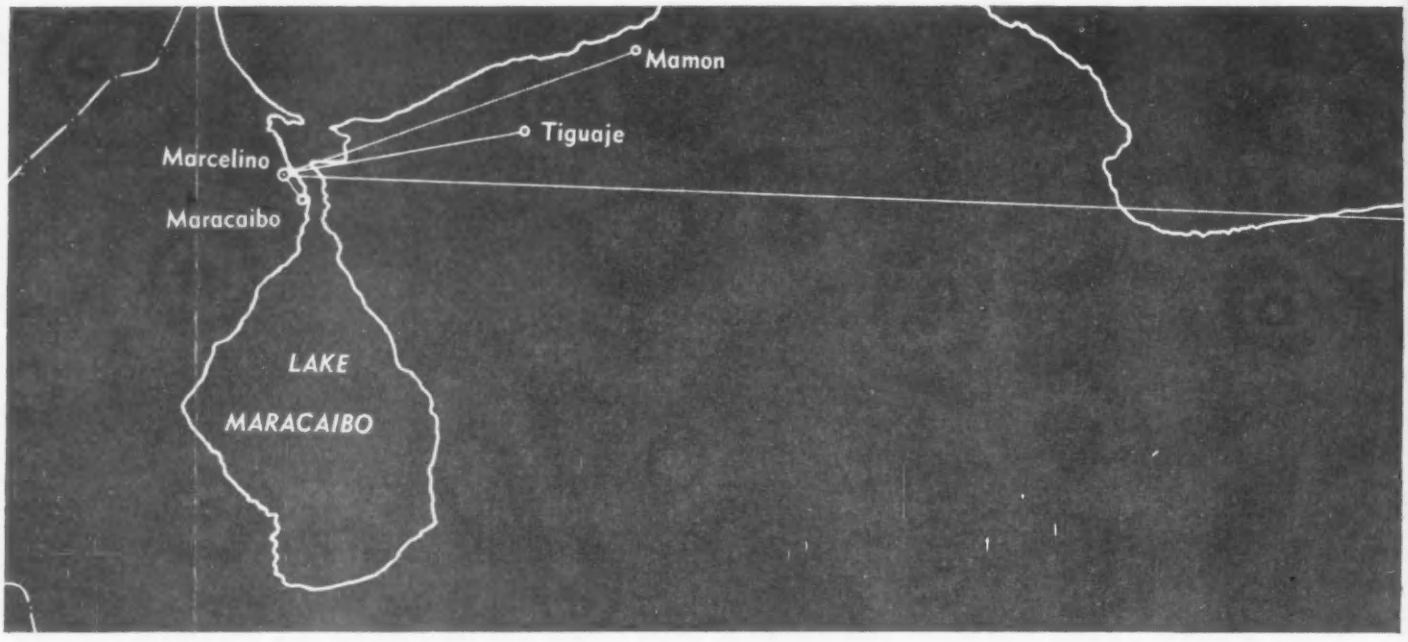


THIS RADIO NETWORK connects Texas Petroleum Company, Venezuelan Division, oil field camps with main offices at Caracas.

How TexPet Uses Radio in Venezuela

Texas Petroleum Company has found that radio communication speeds operations in Venezuela oil fields. So it uses both AM and FM between main offices, field camps, pipe line terminals, and drilling rigs.

By WILLARD W. GRANT, Assistant to Manager, Texas Petroleum Company, Caracas, Venezuela

FAST, ADEQUATE communication between main offices and the field camps has been a perennial problem to oil companies wherever they operate. When good roads and adequate telephone facilities are not available, the need for the oil industry to provide its own means of communication arises. In this respect Latin American countries have proved no exception.

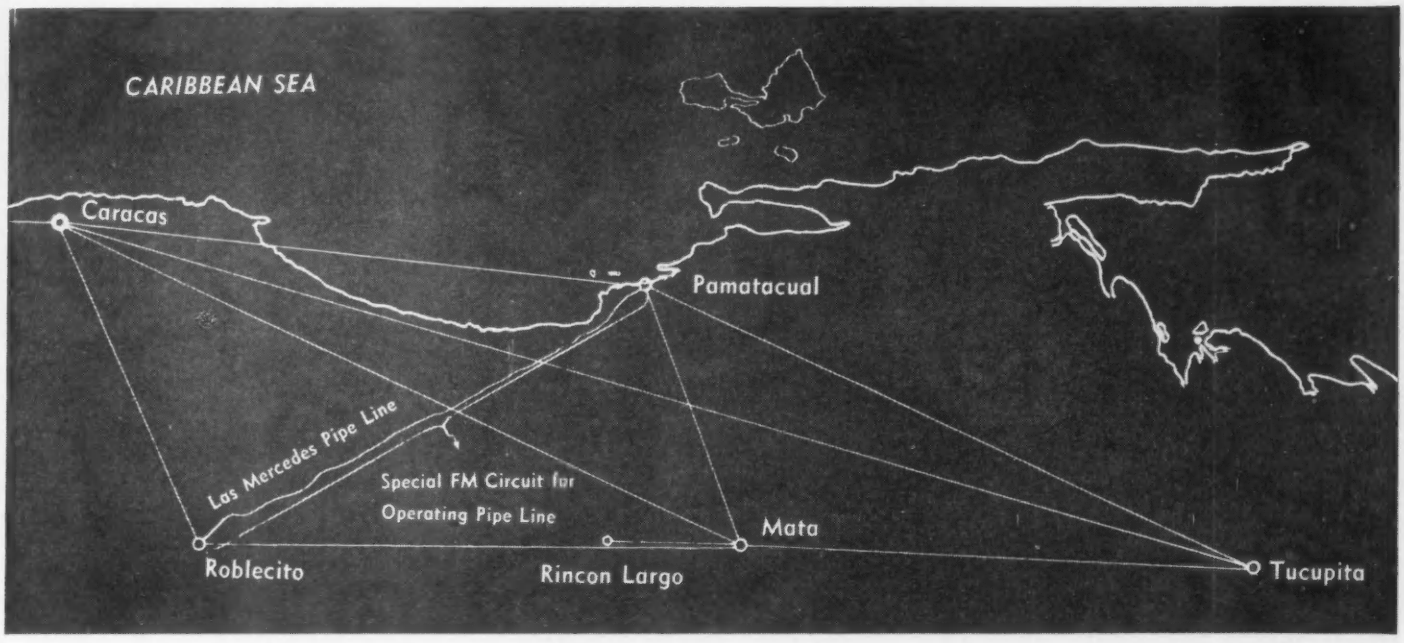
The Republic of Venezuela has long been the largest oil-exporting country in the world, and ever since oil companies first entered that country they have encountered communications problems.

As far as surface communication is concerned, companies have built and still maintain at their own expense a sizable network of roads extending over a large part of the country. For voice-communication companies have relied almost entirely on radio. Among representative oil company radio installations in Venezuela is that maintained by Texas Petroleum Company (The Texas Company's wholly-owned subsidiary) in partial collaboration with Sociedad Anónima Petrolera Las Mercedes (50 percent Texas and 50 percent Caracas Petroleum Company).

Caracas, the capital city is situated very close to the northern Caribbean coast of Venezuela and practically half-way from the eastern and western boundaries. In an office building in the capital's business district, TexPet has installed the heart of its radio system. The central location of Caracas renders it ideal for this purpose since the camps that comprise the company's radio network are situated roughly in a large semicircle with Caracas at the axis (see map).

Desk radio phones. For receiving messages from the camps, there have been installed in the Caracas office five radio receivers monitoring different frequencies. The sending side of the Caracas equipment consists of a 500-watt high frequency, multichannel, remote-controlled transmitter, which, with its respective antennas, is located ten miles away—on the outskirts of the city. The cable from the main office to the transmitter is rented from the local telephone company. All frequencies used are assigned by the Venezuelan government for the various circuits.

Through this radio network, TexPet's managers and department heads in Caracas are in constant contact with all field camps for receiving drilling reports, issuing orders or obtaining information. At the present time, to talk with the field it is necessary to go to a specially designated radio room; however, plans are under way for connecting the circuit into the office switchboard. When that has been



Air-Line Distances Between Radio Stations Forming Part of Texpet Network

	Caracas	Mamon	Maracaibo	Marcelino	Mata	Pamatacual	Rincon Largo	Roblecito	Tiguaje
Mamon	230								
Maracaibo	315	100							
Marcelino	335	110	20						
Mata	210	435	515	535					
Pamatacual	160	390	470	490	85				
Rincon Largo	180	405	475	495	40	70			
Roblecito	105	295	360	390	150	140	115		
Tiguaje	250	40	65	75	460	385	405	300	
Tucupita	340	560	650	665	145	195	180	290	570

Distances are in approximate mileage.

accomplished, it will be possible, for example, for the chief petroleum engineer in Caracas, without leaving his desk, to discuss production problems with his field engineer working 300 or more miles away.

In addition to this main network, which revolves about the head office in Caracas, TexPet has set up smaller circuits whereby outlying drilling or producing locations are tied in directly to the field camp on which they depend. Examples are Mamón and Tiguaje areas, which are controlled by the Western District superintendent located at Marcelino, near Maracaibo.

Each of these two locations is equipped with a 150-watt high frequency transmitter with which daily drilling reports and materials requisitions are passed to Marcelino. Similar installations have been put in at the other principal field camps where drilling and producing operations are under way.

The radio installations referred to previously are all of the AM type. In addition to this, TexPet has found that FM equipment adapts itself well to oil field operations.

Perhaps the best FM example is that installed to operate Las Mercedes' crude oil pipe line, extending from the Roblecito camp, in the central plains of the State of Guarico, to the port terminal of Pamatacual, on the Caribbean Coast. This pipe line is 167 miles long and handles a gross of approximately 50,000 barrels per day.

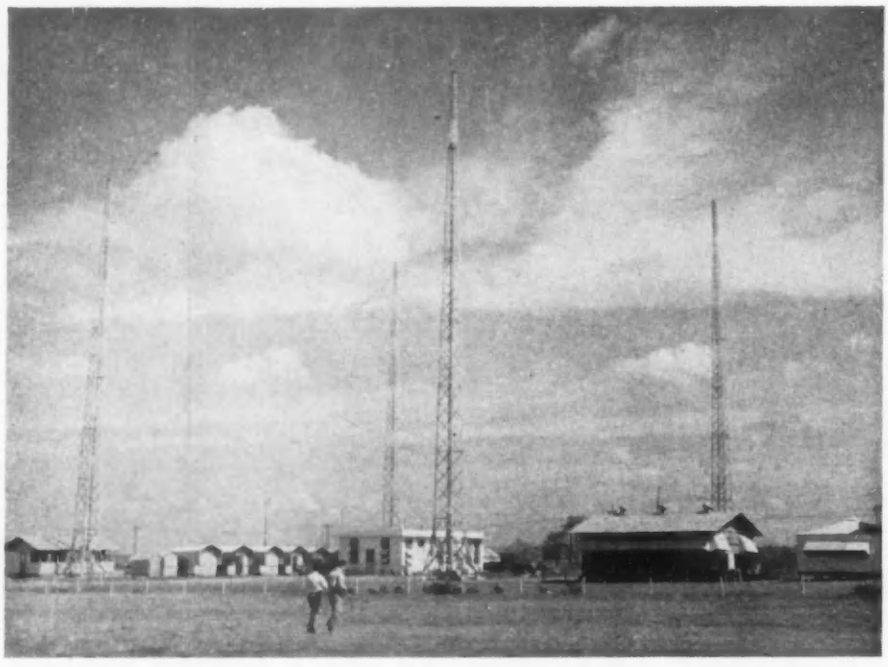
Pipe line patrol. The Las Mercedes crude oil, totaling about 25,000 barrels a day, is gathered from about 220 nearby wells located at Roblecito. This oil, along with an equal amount from outsiders, is pumped into the pipe line. Hourly gages and pressure readings are transmitted between the two main pump stations and the Pamatacual terminal.

In addition, the FM communications circuit has proved helpful in the efficient operation of the pipe line system and allows the offices at either end to keep in constant communication. Two FM mobile units constantly patrol the pipe line to check on corrosion and leaks.

If a leak should occur, a drop in pressure is indicated at the pump stations and Pamatacual terminal. The information is promptly transmitted throughout the system and pump stations are immediately shut down. Mobile repair units are contacted by FM radio and proceed to the spot to make necessary repairs.

Due to the heights of the FM antennas, pipe line patrolling mobile units can communicate between themselves as well as with the two fixed stations at either end. The FM tower at Roblecito is 400 feet high; at Pamatacual the antenna is placed at the top of a 145-foot tower located on a 1500 foot ridge that overlooks the Caribbean Sea. These antennas provide an almost line-of-sight transmission throughout the length of the pipe line and operate entirely without any relay stations.

Numerous other FM installations have been installed throughout the producing operations to provide communication between tank batteries and field offices and between the



TEXPET'S FOUR 145-foot AM radio antenna towers at Roblecito camp on central plains of Venezuela. Company also has a 400-foot FM radio tower at this camp, the starting point of the 167-mile, 50,000-barrels-daily Las Mercedes pipe line extending to Caribbean.

About the Author

W. W. GRANT is assistant to the manager, Venezuelan Division of Texas Petroleum Company, a subsidiary of The Texas Company. His headquarters are in Caracas.

Grant, a native of Evanston, Ill., was graduated from Northwestern University in 1930 with a B.S. degree in mathematics and geology.

He joined Texas Petroleum Company in August, 1946, as a senior accountant in the company's Colombian Division office in Bogota. In May, 1949, he was promoted to chief accountant. On January 1,1954, he was transferred to the Venezuelan Division's Caracas Office as assistant to the manager.

main pump station and tank batteries. All field shipments are controlled through radio transmission. FM installations are provided on wildcat wells located any considerable distance from the field offices, to provide a constant contact.

Where required, operating personnel are provided with FM installations in their cars, enabling them to contact field installations, district office, or central office in Caracas. This eliminates many unnecessary trips, important in time-saving to operations spread approximately 600 miles across the northern part of Venezuela.

Other uses for FM are being found by TexPet's communications engineers. Presently under way are plans for "telemetering" contents of crude oil tanks at some distance from central offices.

For example, on the Roblecito-Pamatacual pipe line there is a take-off that leads into tanks at the Vengref refinery, about three miles from Pamatacual. Since a large portion of the petroleum from the Roblecito field is processed at this refinery instead of being exported as crude, it is necessary for the Las Mercedes foremen to control the volume of oil being pumped into those tanks. By means of telemeters installed at the tanks there is broadcast via FM to Pamatacual a running record of the exact amount of oil in the tanks.

Radio teletypewriters planned. Telemetering is likewise being considered for transmitting gas pressures on wells located at considerable distance from main wells supplying gas to the transmission company providing fuel for the cities of Caracas, La Guajira and others. With these meters pressures may be read at will in the compressor station office.

Therefore, when a pressure failure occurs, it can be spotted immediately and a repair crew can be dispatched directly to the defective well, thus effecting constant pressures with minimum personnel and transportation expense.

DIAL AND MICROPHONE of FM mobile unit installed in a pickup truck patrolling Roblecito-Pamatacual pipe line.

TexPet was planning to install radio teletypewriters at Caracas and main camps. Currently it is necessary for a radio operator to take down in shorthand or on a typewriter the reports, requisitions and routine messages that come in over the network. This, of course, results in duplication of work and calling back and forth to make sure the message has been received correctly.

With the teletypewriter each message will be automatically reproduced at the receiving end just as it was sent out at the sending station, significantly cutting down time consumed in transmitting each message, and will tend toward eliminating transmission errors.

An efficient network of radio communications, such as the one described, has become highly essential for carrying on oil field operations in a foreign country. This is especially so when exploration and development extend over such a wide area as in the case with TexPet in Venezuela.

Under such conditions radio becomes a life-line insofar as it enables TexPet's management in Caracas to keep in constant touch with the operations in the field and, in turn, allows operating personnel to contact their offices for discussion of day-to-day field problems. **—The End**

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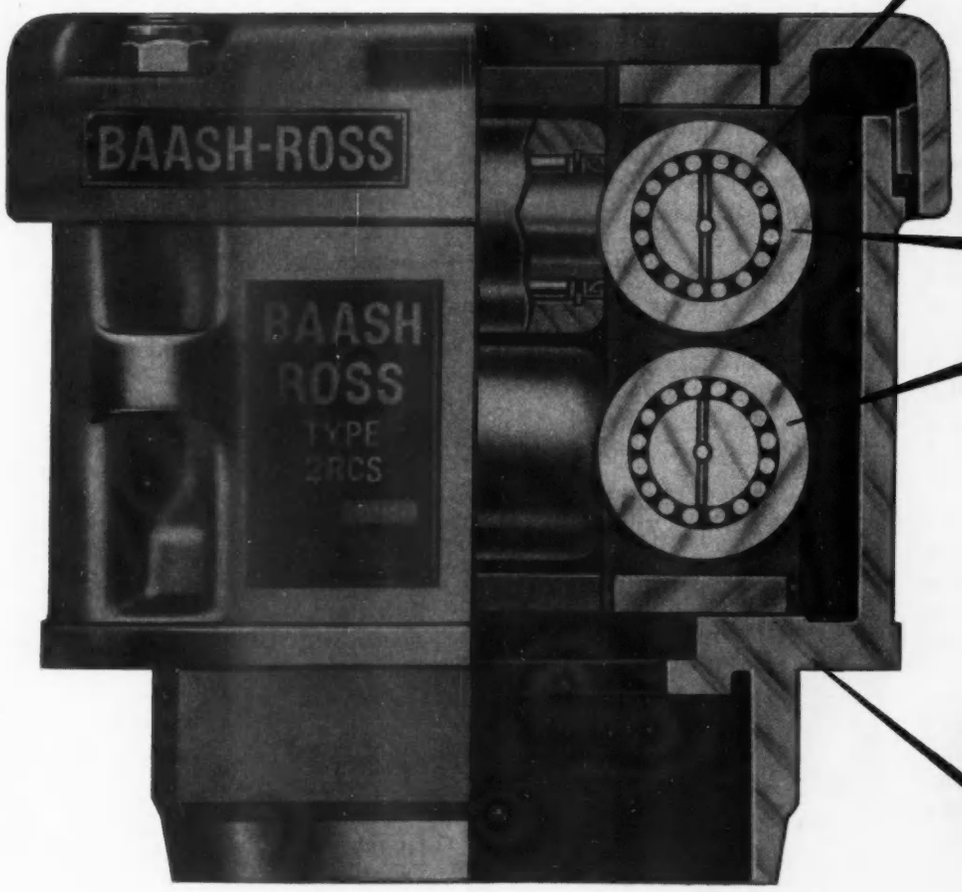

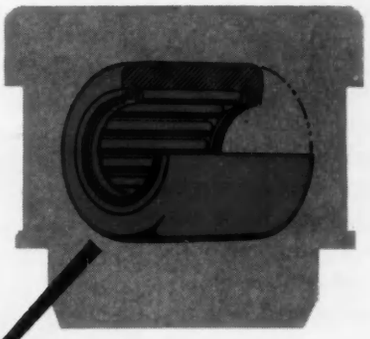

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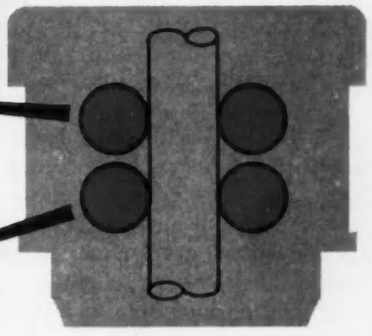

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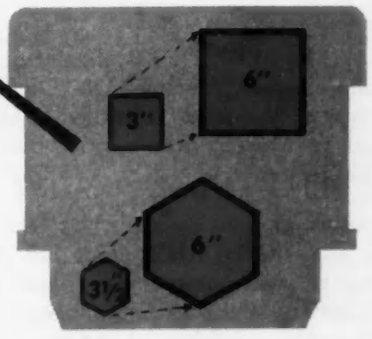

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What's Happening

AMONG WORLD OIL MEN

DUMONT CLARK, member of the board of directors of "Esso Standard Italiana," has left Italy after having been appointed chairman of the new company created by the Standard Oil Company (New Jersey) in Nigeria—Esso West Africa, Inc.

Dumont Clark

Clark entered the "Esso" group in 1946 when he left the U. S. Navy. In the "Esso" group he has occupied important positions in the U. S., Cuba and in various Mediterranean countries.

•

M. SIDDIQUI, director of the Department of Mineral Concessions and director of petroleum in Pakistan, is visiting U. S. oil and gas fields, drilling operations and refineries. After leaving the U. S. for scheduled stops in the United Kingdom and Holland, he plans to return to Pakistan June 1.

•

EDWARD C. BORREGO has been named general manager of Libyan American Oil Company, Texas Gulf Producing Company's wholly-owned subsidiary operating in Libya.

•

A. L. SEELINGER, Eastern division manager, Socony Mobil Oil Company of Venezuela, returned to Caracas in March after a brief business trip to the U. S.

•

J. B. OAKLEY, JR., has been named assistant division engineer at Stanolind Oil and Gas Company's Canadian division. A native Oklahoman, Oakley grew up in Barnsdall and graduated from high school there. He served 3½ years in the Air Force during World War II, graduating from the University of Oklahoma in 1946.

Hired by Stanolind immediately after graduation, Oakley's first job with the company was as a roustabout in Kansas. Later, he served in various engineering assignments for the company in Kansas, Oklahoma and Texas.

He became administrative assistant to the vice president, production, in 1953, and was transferred to Houston as petroleum engineer, senior grade, in 1954. In 1955 he was moved to Calgary as senior petroleum engineer.

•

FERNANDO J. ESPINOSA has been appointed general manager of International Petroleum (Colombia) Limited and assistant executive representative of International Petroleum's interests in Colombia. For the past four years, he has been general manager of Esso Colombiana S. A., International's marketing affiliate in Colombia.

A former resident of Washington, D. C., Espinosa was graduated from the University of Florida in 1933 and has lived in Bogota since 1946.

•

JOHN NOBLE was elected president of Trans-Arabian Pipe Line Company (Tapline) and has resigned his former post as associate general counsel of Arabian American Oil Company in favor of his new position. C. A. SWIGART, president of Tapline since 1951, was named chairman of the board and chief executive officer. W. R. CHANDLER, Tapline vice president, has been named executive vice president.

John Noble

•

The Texas Company has announced the following personnel changes:

R. L. LAY has been named assistant to the vice president in charge of operations in the Eastern Hemisphere.

W. N. HOLT will serve as a director and vice president of The Texas Company (Iran) Ltd. with offices in London, England.

Veteran Oil Man Honored

C. W. Hamilton (left), vice president of Gulf Coast Oil Corporation and board chairman of Gulf Eastern Company, recently received his 40-year service award in London from R. O. Rhodes, senior vice president for production. Hamilton started his career in Mexico, and joined Gulf in 1916 as chief geologist for Mexican Gulf Oil Company. He became vice president for Gulf Oil Corporation's Foreign Production division in 1940 and assumed duties of board chairman for Gulf Eastern in 1955.

IAN M. COOK, a native of Edmonton, Canada, has been named chief geologist for the D. D. Feldman Oil & Gas Canadian operations. He now resides in Calgary, where he has been an independent consultant since March, 1949.

He was born in Edmonton in 1917 and attended public schools there and graduated from the University of Alberta. From 1940 until 1943 was with the Petroleum and Natural Gas Conservation Board, Alberta, ending as chief geologist, and spent the next three years, until 1947, working for the British American Oil Company with headquarters in Calgary. After a year with Union Oil Company of California as an associate geologist in Calgary and another year as senior geologist in Calgary for Stanolind Oil and Gas Company he went into the independent consulting field.

Cook did much of the original work on the productive possibilities of the Devonian sediments in Alberta.

•

DON ANDERSON of Calgary, Canada, has been named local manager of operations for Canada-Cities Service Petroleum Corporation.

Anderson, who has been superintendent of oil operations for the Canadian company the past four years, will supervise all operations of the company—including production and exploration. In his new job, Anderson assumes the exploration responsibilities of Z. E. STUCKY, who is being transferred to another Cities Service operation.

a WORLD of OIL

By **DON KLIEWER,** World Oil Staff

ALGIERS: Compagnie de Recherches et d'Exploitation de Petrole au Sahara reportedly has discovered oil in a wildcat between Fort Flatters and the Libyan border which apparently confirms existence of oil in the Sahara. Located about 1000 miles south of Algiers, geography of the area likely will be an obstacle to further development.

AUSTRALIA: Santos Limited is drilling its first test well at Wilkatana, about 30 miles north of Port Augusta, and traces of light oil were found at 230 feet and between 440 and 549 feet, with a showing of low gravity crude at 574 feet.

AUSTRIA: The 1955 trade agreement with Rumania has been extended for another year under which Austria will buy fuel oil worth $750,000 in 1956.

BAHAMAS: Bahama California Oil Company and Bahama Exploration Company will begin a joint marine seismic survey of the 1700-square mile Cay Sal area.

BRITISH BORNEO: Seria field (110,000-barrel-a-day production) rapidly is increasing in importance, and an imminent extension of drilling beneath the South China Sea is likely to increase interest in the region.

BULGARIA: Russia reportedly has rejected a Bulgarian invitation to join this satellite nation in petroleum industry development.

CANADA: Cremona Pipe Lines Ltd. has won the three-way competition for permit to build a $2,750,000, 60-mile, 18,000-barrel-daily pipe line linking Sundre-Westward Ho-Harmattan oil-producing areas with Calgary refineries.

CUBA: Atlantic Refining Company is participating in the drilling of a wildcat in northwest Camaguey province in cooperation with Dr. Antonio Iglesias, a discoverer of the Jatibonico field. This is the first drilling activity in Cuba since 1946 for Atlantic, which holds extensive acreage in the area of the drillsite.

CZECHOSLOVAKIA: Crude production for 1955 amounted to an estimated 1,354,000 barrels, which was below the quota, as compared with an estimated 1,218,000 barrels for 1954 . . . The drilling industry is expanding the use of Soviet deep drilling equipment (up to 9600 feet) to reach deeper horizons at Hodonin and Malacky.

EAST GERMANY: Crude output for 1955 is estimated to have reached 332,150 barrels.

EGYPT: Southern California Petroleum Corporation has negotiated a new two-year drilling contract with International Egyptian Oil Company, Inc., and also has organized a wholly-owned foreign subsidiary drilling company, Camdrill International, Inc., a Panama corporation, to handle the new drilling contract.

FRANCE: The British Petroleum Company, Ltd.'s French affiliate, Societe Francaise des Petroles BP, has ordered a 33,000-ton tanker from Ateliers et Chantiers de France.

Extends Search to Malta

British Petroleum Company Ltd's subsidiary D'Arcy Exploration Company has conducted geophysical surveys over Malta and a smaller neighboring island, Gozo. Three drillsites for strat tests on Malta have been staked, and drilling (see photo) is in progress at the first —Zabbar 1—near Zabbar, three miles inland from Valetta, the capital. A paleontological laboratory has been established at Valetta.

GERMANY: Gewerkschaft Elwerath's wildcat Grob-Gerau 1 in the Upper Rhine valley near Darmstadt has discovered natural gas between 1585 feet and 1675 feet, with production tests yielding at an initial rate of about 700,000 cubic feet daily.

HUNGARY: Reports are yet unavailable on exploratory work in the Feisoerajk area that was begun in 1955 and which subsequently has been expanded into the Kiliman-Pasca area.

INDIA: An aeromagnetic survey is being sponsored by the government over a 17,000-square mile area, including Jaisalmer and Ramgarh, with Jodhpur as base of operations.

ISRAEL: Heletz 3, the nation's second oil producer, flowed oil to the surface on open-hole drill stem test from 4920 feet. Reportedly, this test, a 1400-foot northwest stepout from Heletz 1, completed last fall, has picked up both oil sands found in the discovery well . . . Heletz 2, meanwhile, had reached a depth of 4930 feet.

ITALIAN SOMALILAND: Sinclair Somal Corporation will drill a deep test on its 92,000-square mile concession, and was to make a beach landing near Obia on the Indian ocean.

NEUTRAL ZONE: Pacific Western Oil Corporation has estimated crude reserves of the Burghan sand of Wafra field at 650 million barrels.

NEW ZEALAND: The British Petroleum Group, through its subsidiary, D'Arcy Exploration Company, Ltd., has entered a $2.8 million New Zealand oil exploration agreement with the Shell Group and Todd Brothers Limited in the Taranaki and Rangitikei areas in the central and western districts of the North Island.

PAKISTAN: Pakistan Oil Fields Limited, a subsidiary of The Attock Oil Co. Ltd., has drilled a test well at Karsal, seven miles west of Attock Oil's Balkassar field near Chakwal in the Jhelum district, to 11,928 feet with oil indications which were being tested.

PERU: Texas Petroleum Company's second well on the Maranon river, about 140 miles downstream from the first, was drilling at 8941 feet. The first Maranon well was abandoned at 9787 feet because of technical difficulties.

SAUDI ARABIA: Crude production during February amounted to a daily

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average of 1,013,765 barrels, reports Arabian American Oil Company.

VENEZUELA: In addition to the dredging job recently completed by the government at the mouth of Lake Maracaibo, where a 36-foot deep channel adequate for loaded supertankers was created, plans for a bridge across this channel were in the offing . . . Creole Petroleum Corporation's net production, plus purchased royalty oil, last year averaged 980,147 barrels daily—up 19 percent from 1954.

YEMEN: The British Petroleum Company's subsidiary, D'Arcy Exploration Company, has obtained an oil exploration license covering the British group of Kamaran Islands and their territorial waters off the Yemen coast in the southern part of the Red Sea.

Increased Use of Sui Natural Gas Forecast

Currently, 35 Mmcf of natural gas is being transported by the 350-mile, 16-inch Sui-to-Karachi pipe line, but it is expected that 100 Mmcf a day will be transported within a year or so.

This forecast was made recently by M. Siddiqui, director, Department of Mineral Concessions and petroleum director for the government of Pakistan, during a visit to Houston, Texas.

Paralleling this increased natural gas production, Director Siddiqui said rising crude production will fill a big void in his nation's economic picture. Currently, Pakistan's crude production amounts to 4500 barrels a day.

Now in the midst of an industrial revolution, the government petroleum official said, Pakistan's domestic crude demand is three times greater than in 1948. So, $40 million worth of petroleum products must be imported annually to satisfy this demand, he explained, adding that increased domestic output not only will solve Pakistan's fuel problem but also bring in needed money.

Director Siddiqui was in Texas to visit oil field installations and to conclude negotiations with the H. L. Hunt interests. Nelson Bunker Hunt, H. L. Hunt's son, is heading a family organization which plans to begin prospecting soon on 20,000 square miles in Pakistan.

Valuation Problem Abroad Is Described

The occupation of a valuation engineer abroad was described as one of the most hazardous in industry by James Terry Duce, vice president, Arabian American Oil Company, at a conference of the American Institute of Mining, Metallurgical and Petroleum Engineers at Dallas, Texas, March 29-30.

In supporting that description, Duce sketched the difficulties involved in operations abroad and the paralleling difficulties in arriving at any valuation of some of these properties.

The great factor in such valuation, he explained, "is the assessment of the political risks that are involved in the operations in any particular country."

"This requires careful and mature political judgment and even this is sometimes upset by matters which hardly can be foreseen. The question of technical problems of oil reserves are exactly the same as they are in the U. S. Chances are, however, that deferment may well loom large and that the provision of facilities for disposing of the oil in world markets will loom even larger as factors in the valuation," he said.

The science of valuation of oil properties other than those in the U. S. and Canada, he said, is in its infancy, if it is a science at all, for not many such properties are transferred and those that are, are usually transferred on the basis of considerations other than their money value, he added.

Duce said when he recalls the number of properties abroad that he knows to have been sold, he finds the number is very small:

"The Barco concession, various interests of Aramco, Venezuelan royalties of Barber Asphalt Company, and such trades as were made by The Texas Company for its interest in the properties of the Caracas Petroleum, the Lago Purchase by Esso from Standard of Indiana, the Creole trade, the purchase of London-Pacific Petroleum's Parinas Estate at Negritos and Talara, Peru, by International Petroleum in (or about) 1916, and the deal made by Shell and Jersey for interest in Mene Granede (Gulf) production.

Duce said "the trouble with any discussion of such trades is that beside the value of the actual oil content of the property, the really important considerations lie within the time-honored expression 'discount for risk and hazard' and in many of the major properties the recovery of the oil in the fields is so much deferred that the valuation tables will give you the astonishing information that much of the oil is of practically no value at all.

"When long deferment is at the same time linked with factors of risk and hazard as great as they are in the foreign area, one, indeed, faces special problems."

Some of the hazards, Duce said, are:

1. The problem of estimating the action of any nation with relation to its concessionaires.

2. Internal changes.

Referring to the Middle East, Duce described what he said "seems to be a point of stabilization."

". . . That is to say, that 50 percent of the profits go to the governments. There will, of course, arise in that area disputes as to the meaning of this, but I think it would be a very unwise valuation engineer who would try to set a value on oil there which might be produced ten years hence.

"I might add, the present production in the Middle East, compared with present calculated reserves, indicates that we have in sight over 100 years' supply . . . Large discoveries have been made this year and, to my belief, will continue to be made for a number of years to come. Some of the fields are incomparably the largest in the world, among which I might mention the Ghawar field in Saudi Arabia, Gach Saran in Iran, Burgan in Kuwait, and Kirkuk in Iraq.

"The value of concessions in this area, therefore, is based on the oil you can sell within a reasonable time."

Duce said that he did not want to appear pessimistic, for operations abroad "have been very profitable in the case of the few successful ventures."

In conclusion, Duce described the cost of discovering oil abroad ("begins at $10 million") and the problem of geography (where heavy investment

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"I think," he said, "this sketches the difficulties which are involved in these operations and gives you some idea of immense difficulties in arriving at any valuation of some of these properties.

"Nevertheless, I can assure you that when a foreign operation is profitable, it is profitable chiefly because the goods come in large packages."

Jamaican Stanolind To Spud in Its First Test

Jamaican Stanolind Oil Company will spud in its first exploratory well in Jamaica next month. It will be the second exploratory hole seeking oil and gas ever drilled on the island. Jamaican Stanolind is a wholly-owned subsidiary of Stanolind Oil and Gas Company.

The wildcat—Santa Cruz 1—is located 2650 feet above sea level on Santa Cruz mountain, five miles south of Malvern and one mile east of Munro College in St. Elizabeth parish. The location now is being cleared.

Jamaica's first exploratory well was drilled last year by Base Metals Mining Corporation at Negril Spots, about 45 miles northwest of Jamaican Stanolind's Santa Cruz 1. The Base Metals well was dry, but provided encouraging geological information.

The planned wildcat is part of Jamaican Stanolind's $2 million exploration program, on acreage which includes the entire land area of Jamaica and submerged lands an average of 12 miles offshore surrounding the island.

To date, Jamaican Stanolind contract exploration crews have concentrated their activities in the two areas of Savanna La Mar and Santa Cruz mountain. Plans call for expanding operations soon to cover areas near Spanish Town, Portland Point, Chapelton, St. Ann's Bay and Lucea.

In addition to drilling, Jamaican Stanolind's program includes geological surveys by two parties in the Savanna La Mar and Santa Cruz Mountain areas. A seismograph crew is working now in the Negril Spots area and has completed some tests west of Malvern.

A core-drilling crew has been working near Little London in the Savanna La Mar area. All exploratory work is being carried out by contract crews working for Jamaican Stanolind.

Jamaican Stanolind became active in the island early this year after signing a three-way agreement with Base Metals and the Jamaican government to take over exclusive prospecting licenses formerly held by Base Metals. Base Metals will receive 25 percent interest in any producing wells.

Jamaican Stanolind began work in early February with two surface parties, and soon will expand this operation to four parties. A core drill crew began operations Feb. 10, the seismograph crew, Feb. 20.

Blowout First Stanvac Discovery in Papua

Kuru 1, Australasian Petroleum Company and Island Exploration Company's latest test in Papua, blew out in January at 998 feet. Surface casing, 18⅝-inch, had been cemented to 449 feet. After the blowout occurred, the well was cemented off to 400 feet, but gas continued to escape around the plug. Myron Kinley, Houston, Texas, oil well fire-fighter, was flown to New Guinea to take charge of controlling the difficulty.

This well is the first apparently successful result of 20 years' search on the part of Stanvac subsidiary companies for oil and gas in the Papuan jungle, during which $36 million has been spent and more than 85,000 feet of hole has been drilled.

Russia Says 1955 Crude Yield 1,365,000 BPD

Russia reports that its oil industry fulfilled the crude production quota for last year on December 18, its natural gas plan on December 9, and the "light oils" processing quota on December 21.

The annual crude production plan was over-filled by the trusts of Azerbaijan, Bashkiria and Tatria Soviet Socialist Republics.

(Editor's note: It is interesting that after a straight five-year non-fulfillment of the production plan at Azerbaijan, 1955 output reached the prescribed volume. This might be attributed to the extensive application of secondary recovery and to production offshore in the Caspian sea).

Total Russian crude production for 1955 was a reported 19.4 percent greater than the 1954 yield, or a daily average of 1,365,112 barrels. The largest increase was reported from the Ural-Volga area—Ufa, Moltov, Kuibyshev and Saratov fields.

Petrosud Is Continuing Italy Drilling Operations

Although the new Italian petroleum law has not been approved, Petrosud Company (Montecatini Company and Gulf Italia Company) has continued drilling operations in the Abruzzo region. The company has completed two wells with total footage of 16,076 feet and four smaller wells in an effort to establish the limits of the field. Currently, Petrosud is drilling well C5.

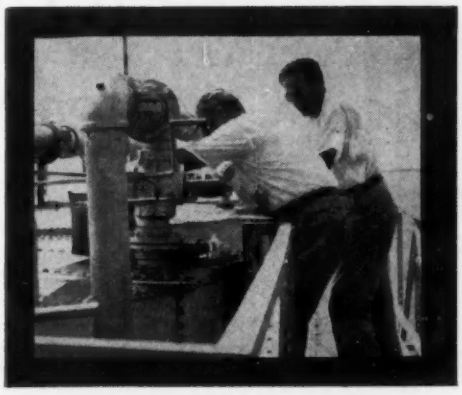
Development of this structure has been delayed, however, because Parliament is still discussing the new oil bill. The Ministry for Industry and Commerce has permitted the production of about 75,000 barrels of oil for analyzing, which has shown that Cingo 2 has a flowing capacity of about 3500 barrels a day.

In the Marche meridionali permit, Petrosud has drilled one well in the Tortoreto railway station zone. The well had reached a depth of 9186 feet. While geological, stratigraphic and seismic research activity is being continued, the company has planned to extend its geological studies to include the coasts of the Marche region.

In Sicily, crude production has shown a sizable increase. Now 70 percent of Italy's crude yield stems from Sicily's Ragusa oil fields. During 1955, ten wells were completed in Ragusa fields with a total footage of 62,881 feet. Two wells were dry holes.

Gulf Italia has limited temporarily Ragusa field production because of lack of adequate transportation facilities from the wells to the Rasiom refinery at Augusta, Sicily. Pending construction of a 14-inch, 46-mile pipe line from the fields to the port of Augusta, only 30 railway tank cars with a capacity of 155 barrels each and a dozen tank trucks with a capacity of less than 100 barrels each are available.

Societa Petroli dell'Isola, Societa Capizzi and Mediterranean Oil Company have drilled about 43,000 feet of hole in the Aragona-Licata, Comiso and Ribera-Caltanisetta permit areas.



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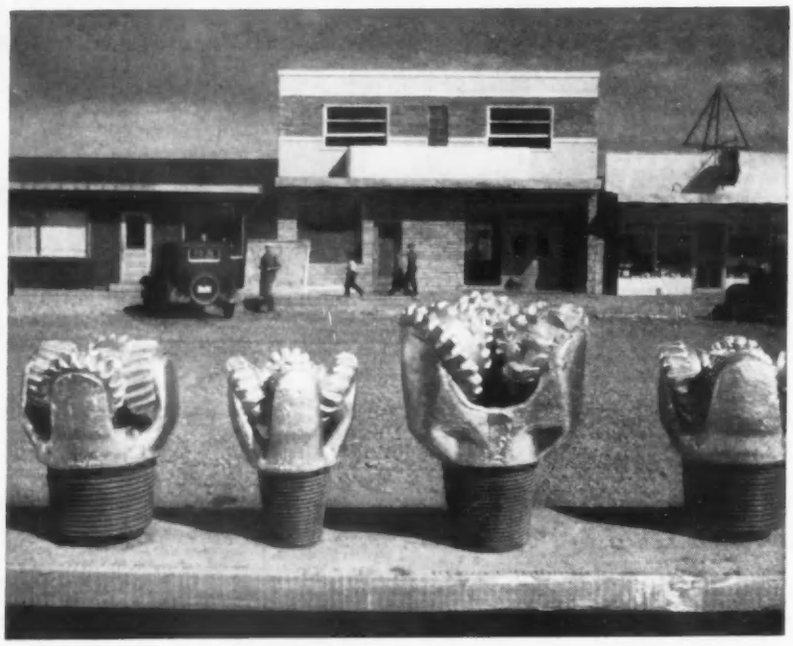

Oil drilling-bits were much rarer than dinosaur teeth in the rocks underlying Canada's prairie provinces until a few decades ago. Now, hundreds of drilling rigs and scores of refineries are capitalizing on the wealth that lies far below ground in Western Canada.

As a pioneer bank in Canadian oil, The Canadian Bank of Commerce will be glad to help you in any activities in which your own firm may be engaged—or may contemplate undertaking—in Canadian oil. We have more than 150 branches in the Sedimentary Basin, and a fully equipped Petroleum and Natural Gas Department located in Calgary, under the management of men of long experience in Canadian oil.

For further information, write to our Business Development Division, Head Office, Toronto 1, Canada—or direct to our Petroleum and Natural Gas Department, 309-8th Avenue West, Calgary, Alberta.

(We do not advise on the merits of specific oil securities)

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Cuban American Gas Well Tests At 5 MMCF

Cristales 1, spudded in by Cuban American Drilling and Exploration Company on the Quadreny Primero concession November 1, 1955, was tested after reaching 8344 feet and found to be a potential 5 million cubic foot per day natural gas well, according to the *Cuba Petroleum News Digest*.

The site was selected after seismic work, and the well is about 12 miles northeast of the intersection of the Majagua toll road and the Central Highway, this intersection being about nine miles east of Jatibonico. The rig is an 8500-foot capacity rig, using 4½-inch drill pipe. Drilling is under contract to Dixie Drilling Company, and James Menefee is toolpusher.

Formation reportedly is mostly hard shale and conglomerate to 3400 feet; shale with some lime stringers from 3400 feet to 4600 feet; and mostly shale and conglomerate with some volcanics from 4600 feet to 8344 feet.

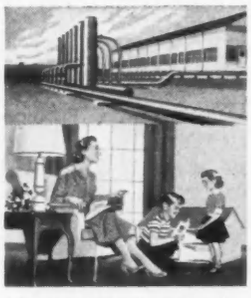
A 12½-inch bit was used to 185 feet and, after reaming to this depth with a 17½-inch bit, 13⅜-inch surface casing was set, and the hole was drilled to 8344 feet with 8¾-inch bit. A 5½-inch production string was set to 2898 feet after logging. A squeeze job at 1720 feet shut off water above to permit testing for gas at about 2700 feet. Thirty feet of a possible 140-foot zone was perforated March 16 with 100 bullets.

March 18 the well was acidized with 5000 gallons and gas was obtained at 2700 feet. After testing intermittently for two days, the well was estimated as a potential 5 million cubic feet per day producer.

Reportedly, the company may later perforate more of the 140-foot zone at or about 2700 feet and/or may test for oil at 1600 feet.

Thirty-one cores were cut during the drilling of the well. Seven drill stem tests were run on shows at various depths. The level now producing—2700 feet—was drill stem tested early in December last year.

Under the original agreement with Cuban Venezuelan Oil Voting Trust and Trans-Cuba Oil Company, one half of Cuban American production goes to CVOVT.



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It's the clean, healthful, even heat gas provides. It's also the economy and comfort of automatic heating at its best. The simplicity and low cost of the installation. The elimination of delivery and storage problems. The assurance of unfailing supply... for gas traveling underground is never stopped by weather or traffic.

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One of a series of advertisements appearing in full color in national publications.

So Rapid and Dramatic has been the progress of natural gas, consumers are not always aware of the latest developments.

TGT advertising is designed to keep the public informed. By telling millions of the convenience, cleanliness, availability of this great natural fuel, ads like this broaden the market... create greater goodwill for the whole industry.

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DRILLING HINTS

These **How-To-Do-It** Ideas Can Save You Money

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.

Set Up Stove Outside To Dry Drilling Samples

During the warm months of the year when the stove has to be lit to dry drilling samples, one contractor moves the stove outside the doghouse and sets it up near the mud sample box. Then the samples can be put on to dry without the derrick man having to carry them to the derrick floor, or having a fire going in the doghouse.

The stove set-up consists of a drum of diesel fuel, resting on another drum set upright. The stove is made from a piece of 10-inch pipe with a 6-inch stack. It rests on legs made from angle iron. A flap on the front is used to adjust the damper. The fuel is carried through a copper tubing to a point inside the firebox where it drops on the flame, adjustment being made at a needle valve on the drum. A flat place is cut out on the top of the firebox to make a level surface on which to place the samples.

Unitized Mud System Cuts Pipe Work

One of the simplest ways of eliminating a lot of pipe work and minimizing rig-up time is to unitize the mud lines wherever possible. A number of contractors have made use of the 4-inch pipe that forms the frame work for the steel mud tanks. The pipe does the added job of forming a part of the mud line for mud guns and jets.

The 4-inch line along one side of the tank must be left open ended and threaded for a union connection. Along the sides of the tank at appropriate intervals, 2-inch collars are welded to the 4-inch and a 2-inch nipple and union are installed. This connection makes the installation of the mud guns a simple matter when rigging up.

The tanks are spotted a predetermined distance apart so that the same 4-inch nipple will connect two or more tanks. The large flow line connecting the two tanks is connected with steel line and sleeves or with rubber hose.

There are no long mud lines to lay. Pipe threading and nippling up is practically eliminated, and it takes but a few minutes to stab the mud guns and jet lines and connect the tanks together when they are spotted on location.

How-To-Do-It Ideas Earn Money, too!

$10—WORLD OIL editors want how-to-do-it ideas, so your favorite short cut or invention could put money in your pocket! Write down the substance of that latest idea and send it in with a picture or drawing of the installation . . . if accepted, $10 will be yours. Send those money-making ideas today to Hints Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.

"When I want a **HOLE OPENER**

"When I want a **3-CUTTER BIT**

"When I want a **4-CUTTER BIT**

I CALL *HCSmith* – because Smith makes 'em all!"

You don't have to shop around, because there's an H. C. Smith Bit or Hole Opener to handle every type of formation all the way from spudding-in to the bottom of the well...and you have your choice of either 3-cutter or 4-cutter types.

Don't take our word for it—ask the many drillers who use Smith Bits and Hole Openers by their own choice. They may not talk about the all-forged bit bodies that give extra strength, the scientific tooth designs and patterns or the triple-bearing construction of Smith Bits and Hole Openers, but they can sure tell you about fast footage in all types of formations, the long, trouble-free life, and the ease of keeping the hole straight when you use H. C. Smith Bits and Hole Openers from top-hole digging to total depth.

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H. C. SMITH OIL TOOL CO.

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USE KINZBACH WHIPSTOCKS AND MILLS TO SIDETRACK YOUR HEADACHES

Type "A" Mill

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Kinzbach Whipstocks can be set at any depth and require no support for the bottom. Positive setting slips prevent slipping or turning in the hole. The Kinzbach hinge arrangement assures that the top of the Whipstock will be close against pipe wall at all times, permitting easy passage of drilling tools. Setting trigger always locates the Whipstock between couplings so that the window will be within one joint. Kinzbach Whipstocks are available in all popular casing sizes through your supply store.

Use Kinzbach Milling Tools for every whipstocking or metal cutting operation. They have high-speed tool steel inserts which are ground and set at the most efficient angle for fast, uniform cutting action. Shown at left are four popular models—see your Kinzbach Catalog for a description of the complete series of Milling Tools.

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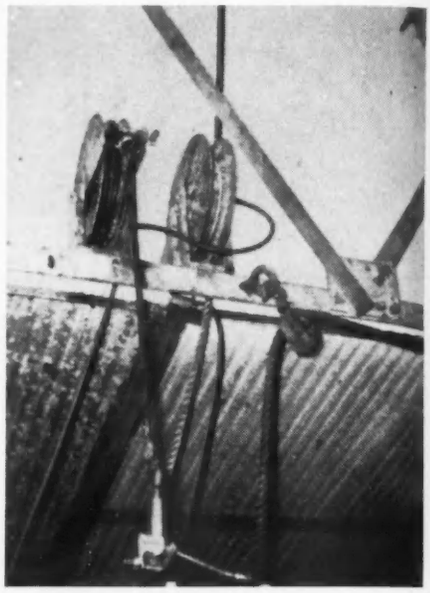


Central System Assures Regular Greasing Job

Daily greasing of equipment is standard practice on most rigs. This practice lengthens life of the equipment and is important to good performance. Unless the greasing set-up is located conveniently and easy to use, greasing of equipment may be anything but regular.

To assure regular greasing of equipment, one Gulf Coast contractor installed a take-up reel for the grease hose and gun. This reel was mounted on a girt over the drawworks. In this location any equipment on the floor, as well as the drawworks, can be serviced. Pressurized grease storage is located out of the way behind the drawworks.

Skid-Mounted Holders Ease Drum Handling

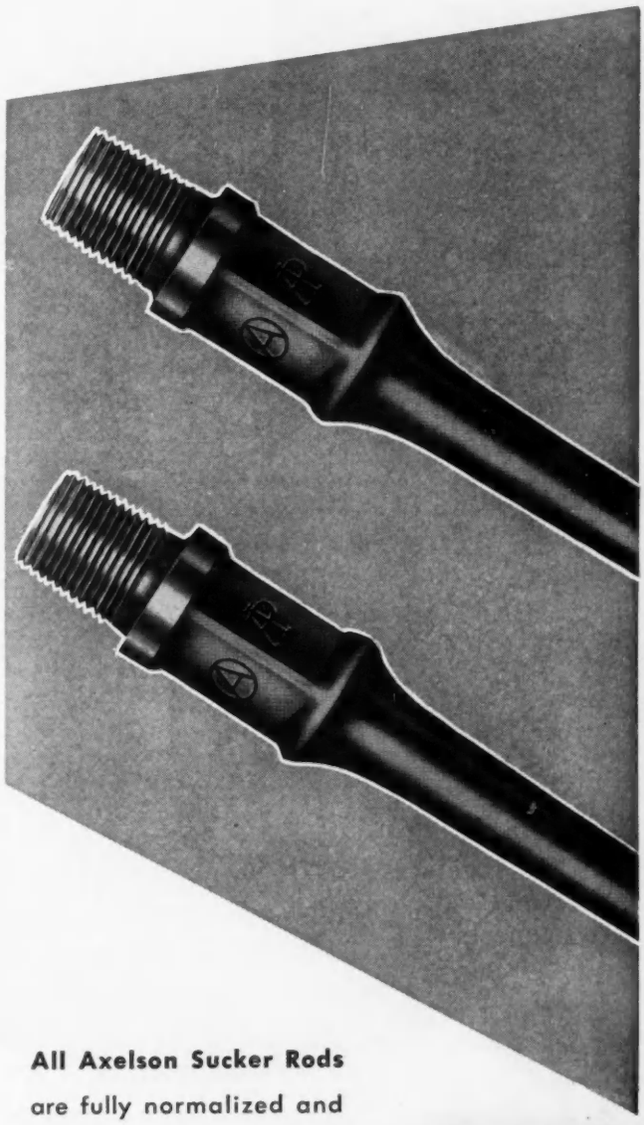
Storage and handling of drums of lubricants and solvents on the drilling location can be eased and the every day handling of lubricants can be made safe and easy by providing a convenient drum holder.

The illustrated holder, which has space for three drums, could easily be expanded to fit needs of the individual contractor.

The drums are secured in semi-circular bails constructed from sheet

Let J&L Help

Cut Lifting Costs with Axelson Trouble-Free Rods



HEAVY LOADS and irregularities in pumping? Ask your J&L man for Axelson No. 59 Sucker Rods, made of nickel-molybdenum alloy steel to resist corrosion fatigue.

AVERAGE TO HEAVY conditions? Ask your J&L man for Axelson No. 60 Sucker Rods, made of high grade carbon-manganese steel.

EXTREMELY HEAVY LOADS where corrosion is not a serious factor? Ask your J&L man for Axelson No. 77 Sucker Rods, designed for long-stroke pumping with low impulse factors. Made of nickel-molybdenum alloy steel.

SEVERE SERVICE (high loads, corrosive conditions, high impact and other stresses)? Ask your J&L man for Axelson No. 79 Sucker Rods, made of nickel-molybdenum-vanadium alloy steel.

HIGHLY VISCOUS CRUDES, PARAFFIN or CORROSIVE CONDITIONS? Ask your J&L man for Axelson Hol-O-Rod Sucker Rods for injection of controlling fluids. The FIRST hollow rods with ends integrally forged with the body.

All Axelson Sucker Rods are fully normalized and tempered from end to end after forging but **before** threading. You get maximum strength and ductility. Every rod is as straight as a rifle barrel. Rod ends are designed to eliminate excess stress concentration.

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metal and are held in place with chains. Lugs welded to the bails are supported on bearing posts. Two lengths of pipe extend from the bearing post to the skid base and are welded in place. The skid base provides a level, sturdy frame for the drum rack and facilitates loading on trucks when the drums must be moved.

To facilitate removal of the contents of the drum, a lever arm is welded to the bail. This arm is pulled down to tip the drums for draining.

For Longer Service . . . Greater Joint Strength . . .
More Footage at Lower Cost—

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SPANG
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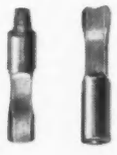
with Forge Hammer-Welded, Fully Heat-Treated, Precision Machined Box and Pin Joints . . .

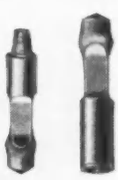
SPANG DRILLING STEMS are made of machine straightened special bar quality open hearth steel, of the right analysis to assure the greatest vibration dampening effect. Box and Pin joints are hammer-welded, fully heat-treated, and have precision machined threads to provide the strongest, most wear-resistant joints obtainable. As a result SPANG DRILLING STEMS, with high strength joints, give longer than average service and drill more footage at lower cost.

REPLACEMENT BOXES AND PINS

. . . of the same carbon steel analysis as those integral with original stems are available in all sizes, lengths and joint combinations for forge or electric welding to stems when renewal is required.

For complete information on Stems and Replacement Boxes and Pins, and for FREE CATALOG of other SPANG CABLE TOOLS, consult your nearest SPANG DEALER or write direct to:





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For over 60 years Manufacturers of Spang Weldless Jars and a Complete Line of Cable System Drilling and Fishing Tools for Oil and Gas Wells, Water Wells, Prospect Drilling and Shot Blast Holes.

Used Drum Provides Extra Storage Space

Storage space, at a premium on many rigs, usually is provided for only standard items. This leaves a fireman or a motor man to find space as best he can for his tools and other equipment.

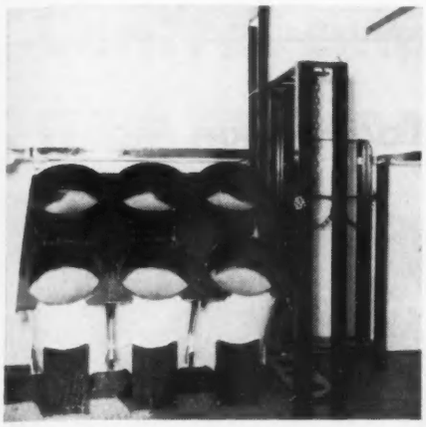
One such fireman took a discarded oil drum and cut out a panel on the lower two-thirds of one side about a quarter of the way around. This made a storage space which was protected from the weather and provided a safe storage for oil cans and oily rags, greatly reducing the fire hazard.

This type of storage can be provided for different facilities around the rig from the type mentioned to a suitable rack for the mud testing equipment.

Make Spare Parts Bin From Scrap Materials

Pump liners and rods are manufactured to close tolerances and are costly to replace. Proper storage for liners, rods and plungers pays dividends in longer life, more efficient service, and a decrease in maintenance costs.

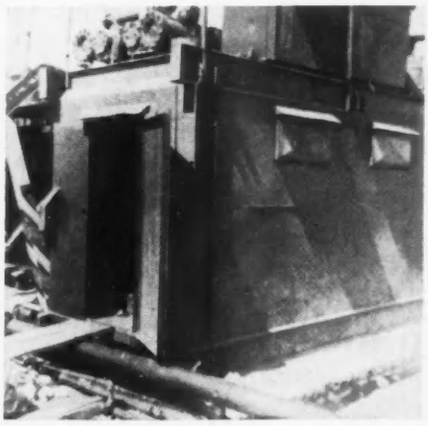
One contractor has had a simple bin arrangement, as shown, installed in the tool house to hold spare liners. All racks were built from scrap that



can be found in almost any contractor's yard.

The angle iron rack with the chain guard is constructed to store spare rods and plungers. Discarded casing with angle iron spacers and braces form the liner rack. These can be made in any size to accommodate the pump size on the rig.

The rod and plunger rack is constructed of angle iron and plate metal. Height of the rack is made to fit individual requirements. Chain guards keep the rods in the racks when moving the rig.



Doghouse in Substructure Save Space and Money

Moving costs are becoming more and more an important item in the contractor's budget. One of many ways to conserve space and save money is to integrate two pieces of equipment.

One idea is to build a doghouse or storage bin in the unused spaces of the substructure. In this instance, the doghouse was built into the substructure by using the rigid substructure braces to form the framework. This not only conserved space and weight but placed the doghouse in a position handy to the work area around the rig.

for better drilling
and better completions

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Seeco-Mul

DRILLING MUD EMULSIFIER

The next time you are on a tough well, convert to an emulsion mud and watch your hole troubles disappear. Use Seeco-Mul, too. A Seeco-Mul emulsion mud makes faster drilling, reduces friction on the drill stem, provides a higher velocity of fluid on bottom, and allows pump pressures to be lowered and more evenly sustained. A Seeco-Mul mud also forms a tougher but thinner wall cake, protects the pay zone from water, and reduces inter-facial tension. Seeco-Mul is exceptionally stable at high temperatures, it is readily soluble in cold water, and it works well at high pressures. You will minimize hole enlargement, too, and your well will come in on production better, easier, and cleaner.

Any qualified mud engineer can use Seeco-Mul without extra equipment or special instructions. Just add it to the system (usually 2 to 3 lbs./Bbl.) through the hopper or the mud hog suction over one or two circulations. Seeco-Mul is packaged in sturdy, moisture-proof 50-pound sacks that are easy to handle around the rig.

Your local mud dealer will be glad to tell you about many other advantages of a Seeco-Mul emulsion mud, or write to us for illustrated literature and a lab sample. We'll be glad to send you full particulars without obligation. Crossett Chemical Company Division of The Crossett Company, P. O. Box 271, Crossett, Arkansas.

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(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

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Doghouse Cradles on Tool Bin on Moves

Unitize your equipment wherever possible so as to cut down on the number of loads necessary when moving. One contractor has built a very unusual arrangement whereby the doghouse is cradled in the tool bin on moves and slides easily in and out of the cradle when rigging up or tearing down.

The extra long tool bin is built with risers, or legs, at one end to support the high end of the slide. The top part of the legs are telescoping and are lowered when in transit. They can be adjusted to fit substructure height.

When tearing down, stairs and catwalks are removed, the front end is raised with a gin pole, front legs are removed, and the front end of the doghouse is lowered. The back side of the doghouse slides in the tracks until the doghouse nestles in the flat cradle over the tool bin. It is then ready for moving.

This arrangement provides a fast, simple method of positioning the tool bin and doghouse and makes a compact load when moving the rig.

Catline Aids Footing on Inclined Walk

When necessary to use inclined walkways to mud tanks, pits or other places around a rig, there always is the danger of accidents due to slippery footing on wet or muddy planks. A simple means of providing traction on a slick incline may be adopted by nailing used catline, or other pieces of soft rope, to the walk as shown.

Beginning at the bottom, tack on a straight piece of rope parallel with the sides of the boards. Then curl the rope from side to side and nail it securely in place. If the rope is not fastened securely, it may cause a man to trip.

Control cement density and thickening time!

DIACEL*
CEMENT SYSTEMS

New, low-water-loss cement additive enables you to control density and thickening time to suit the requirements of wells of all depths and wide temperature range. Versatile Diacel systems give you a choice of densities ranging from 10.5 to 17 pounds per gallon, using ordinary portland cement.

Diacel Cement Systems prevent trouble in the hole. You get better fill-up which reduces damage to pay zone formations due to water lost from the slurry. Diacel cements also help prevent pipe sticking and "flash setting."

You save up to 25% on cementing costs. *And* . . . you get better over-all drilling and completion work with a Diacel cement system. It will pay you to find out more about this new type oil well cement. Send for the full story on Diacel Cement Systems. Free technical handbook on request.

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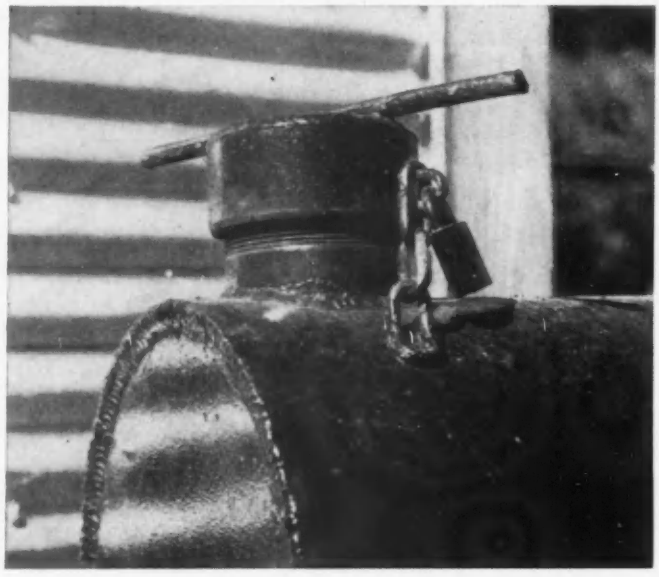

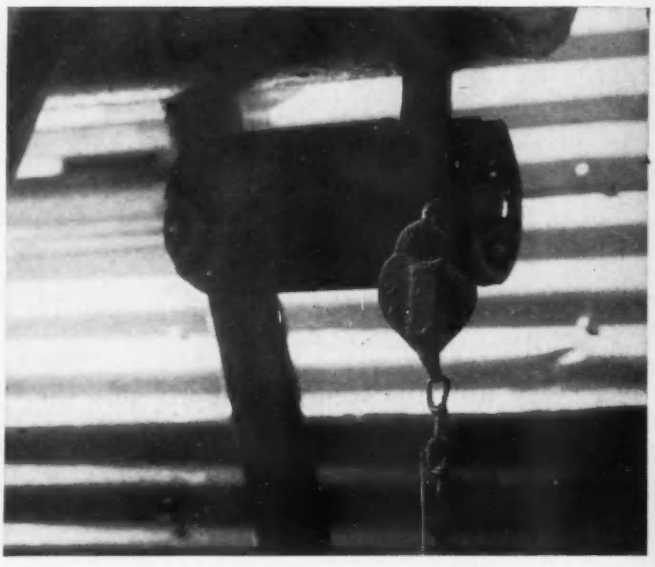

Simple Locking Devices Protect Against Fuel Thievery

Two places to stop fuel theft from storage tanks are at the filling cap and at the drain. Effective locking devices can be simply constructed.

The first illustration shows a locking device on a storage tank made by welding a short length of heavy chain to the tank. A link from the chain is cut off and welded to the gas tank cap. The link is allowed to protrude in much the same manner as a hasp shackle. The last link in the chain is slipped over the half-link welded to the cap and a lock fastened in place, thus the cap is held securely and can be opened only by personnel who have been issued a key.

In making this lock it is necessary to determine the point at which the cap is screwed on securely so that no error will be made in placing the half-link.

The second illustration is a valve handle locking cover. The valve shown is a one-inch gate valve used as a drain. To protect it, a length of 4-inch pipe was used with a plate welded on one end. A slot was cut in the open end to allow the pipe to be slipped over the valve and allow some excess at the open end. In the opposite sides of this open end, two slots were cut to allow a steel strap to be inserted in one slot and extend across to the opening on the opposite side. The strap is made in the shape of a T to prevent it from sliding completely through the slots.

At the foot of the T-shaped strap a small hole is cut to allow a lock to be slipped through and a tamper proof valve guard is created. The lock prevents the strap from being removed on one side and the large end of the T prevents its removal from the other side. With slight modification and cork or sawdust packing, this unit can be winterized for use in cold weather.

How-To-Do-It Ideas Earn Money, too!

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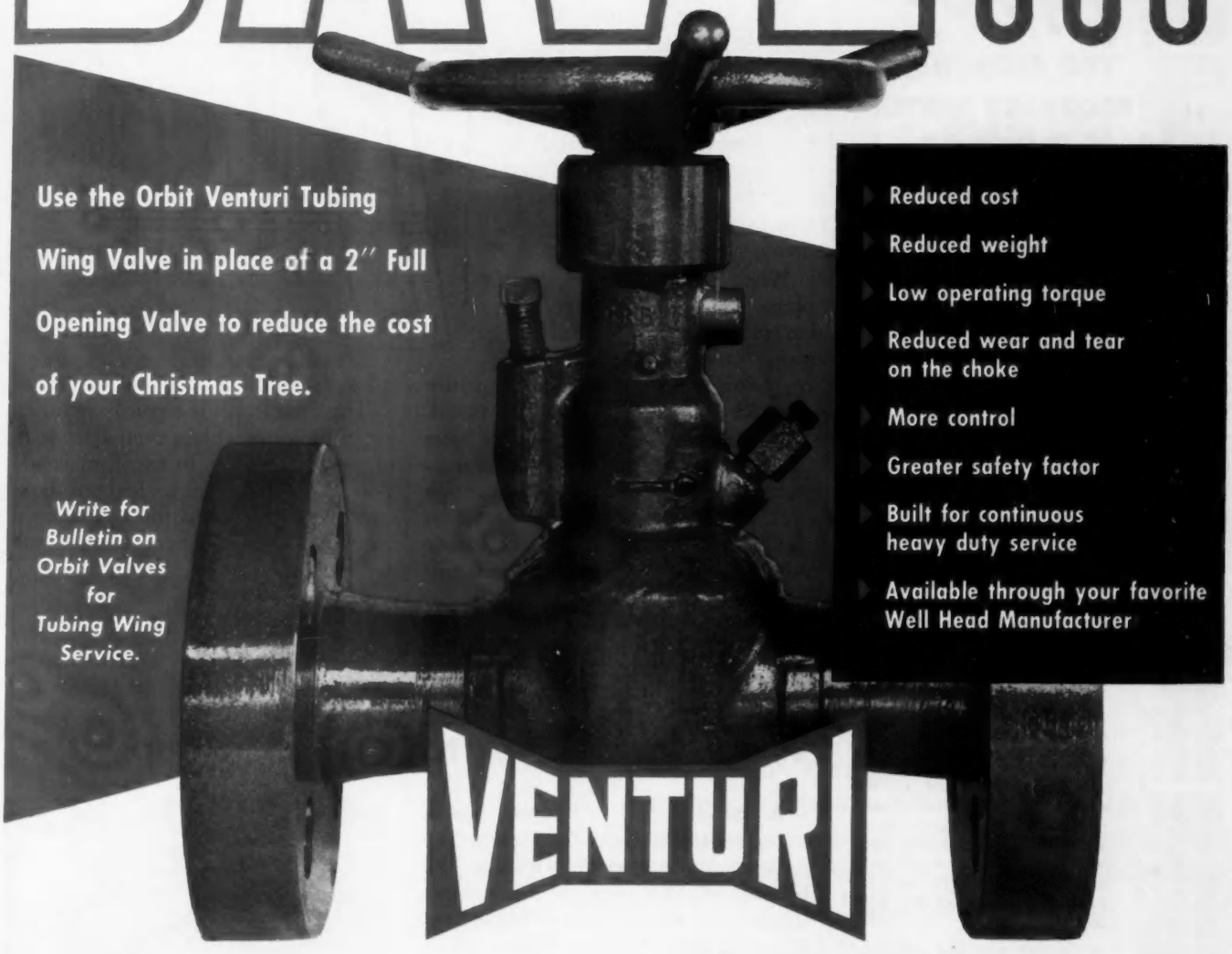
SAVE 000



Use the Orbit Venturi Tubing Wing Valve in place of a 2″ Full Opening Valve to reduce the cost of your Christmas Tree.

Write for Bulletin on Orbit Valves for Tubing Wing Service.

- Reduced cost
- Reduced weight
- Low operating torque
- Reduced wear and tear on the choke
- More control
- Greater safety factor
- Built for continuous heavy duty service
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The Orbit Venturi Tubing Wing Valve is designed for use where a full straight flow is not required.

Available in size 2″ x 1″, Stainless Trim only, API Flanges, Unibolt Hubs or GRALOC* Hubs, Working Pressure of 2000 lbs., 3000 lbs. & 10,000 lbs. End to end dimensions are special.

ORBIT VALVES®

ORBIT VALVE COMPANY

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FOR SECONDARY RECOVERY WATER FLOODING . . .

because pumping with REDA lowers costs and INCREASES PROFITS!

HERE'S HOW:

- Large water volume obtained from smaller size well casings reducing number of supply wells necessary
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- Easier, less expensive installation and lower maintenance costs
- Low operating costs and long operating life of Reda equipment
- Corrosion resistance of Reda pumps is superior to any other pumping unit used in supply wells

Reda Submergible Pumps are a major factor in the success of waterflooding and pressure maintenance operations. They are being used in major floods with very successful results of increased production and lowered costs.

Write for complete information today! Reda engineers will be pleased to call and assist in planning operations.

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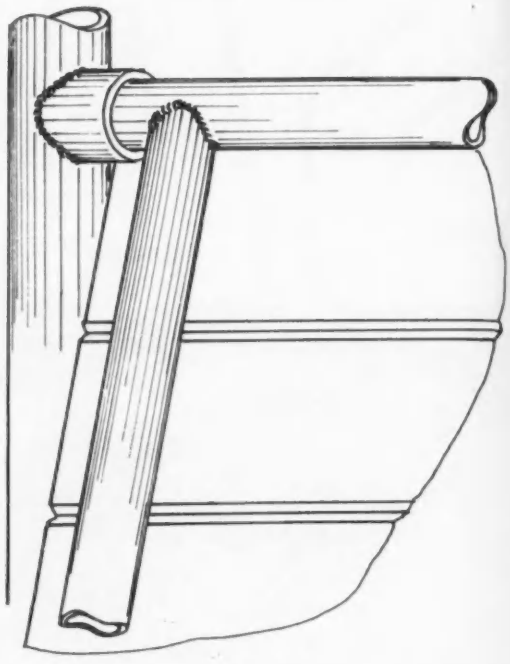
REDA PUMP COMPANY
BARTLESVILLE, OKLA.

Make Maintenance Shop of Used Pipe



An outstanding do-it-yourself idea concerns the construction of a vehicle maintenance shop by a mechanic who is handy with a welding torch. The structure, capable of housing four vehicles, is constructed of used pipe and galvanized sheet metal.

The entire framework is made from various sizes of old pipe welded together to provide a rigid unit. Even the door frames are of welded pipe construction and are pivoted at the top as shown in the illustration. This simple method of hanging allows the lightweight doors to be moved freely.

When the framework is in place, the entire assembly can be painted with aluminum paint to reduce the effective corrosion, and the entire structure covered with galvanized sheet metal. This is done by punching small holes in the sheets opposite the pipe framework and threading iron wire through the holes to lace the sheet metal to the frame. This sort of tie is made every two or three feet to the horizontal and vertical members of the frame.

The final result is a sturdy weatherproof building which, even after years of service, remains in excellent condition. The most unique feature, however, is the fact that the entire structure can be built by one man with one helper.

Weld Barrel Rack to Side of Pickup

A barrel of fuel or lube oil can be carried handily by a jeep or pickup using a simple shop-welded rack. The bottom of the rack is made from angle iron welded into a box shape. Cross members of light steel strip two inches wide form the floor for the barrel. Supporting side rails are made of one-inch pipe, bent and welded to the bottom of the rack and to the side bolsters of the truck box.

A cinch chain holds the barrels securely in position during travel. One end of the chain is welded to the front side rail. A threaded eye bolt fastened to the rear end of the chain passes through a piece of angle iron welded to the opposite side rail. As the nut is tightened on the eye bolt, tension is applied to the chain which holds the barrel securely against the side of the truck.

Slots in Rim of Paint Can Save Time, Reduce Costs

This simple idea will save clean-up time and reduce paint costs around the location. When a new can of paint is opened, punch several holes through the bottom of the sealing rim around the top lip of the can. This allows excess paint wiped off the brush to drip back into the can and not run down the outside.

It will save paint, make a neater job and reduce clean-up time. As an additional benefit, it is easier to reseal the lid on the can when the job is finished and reduces possibility of the lid sticking to the can when reopened.

Use Steel Bars to Make Inside Lock for Shop Doors

An excellent yet simple means of locking shop doors from the inside is shown in this illustration of the corners of two large doors which swing in to a supporting post. Pieces of steel plate are welded to the bottom of the post to stop the inward swing of the doors and to act as jambs for the locking arms.

The arms are made of 1½-inch by ⅛-inch steel strips about 30 inches long. A slight bow is put in the strip to provide a sort of spring action. A bolt is placed through the end of the strip about 2-inches from the end and fastened to the door frame allowing the arm to pivot freely.

When the door is to be locked, the arm is rotated to a horizontal position as illustrated by the arm at the right. In this position the bottom of the arm falls behind the metal plate on the post holding the door shut. The top of the strip is forced against the frame where the spring action keeps it in place. In the case of a wooden door, a small groove can be made in the frame to accommodate the top of the arm.

When not in use, the arm is rotated to a vertical position freeing the bottom of the strip from the door jamb and allowing the door to swing open. In this case a small loop of wire is used to retain the arm in this position. However, several other variations are possible.

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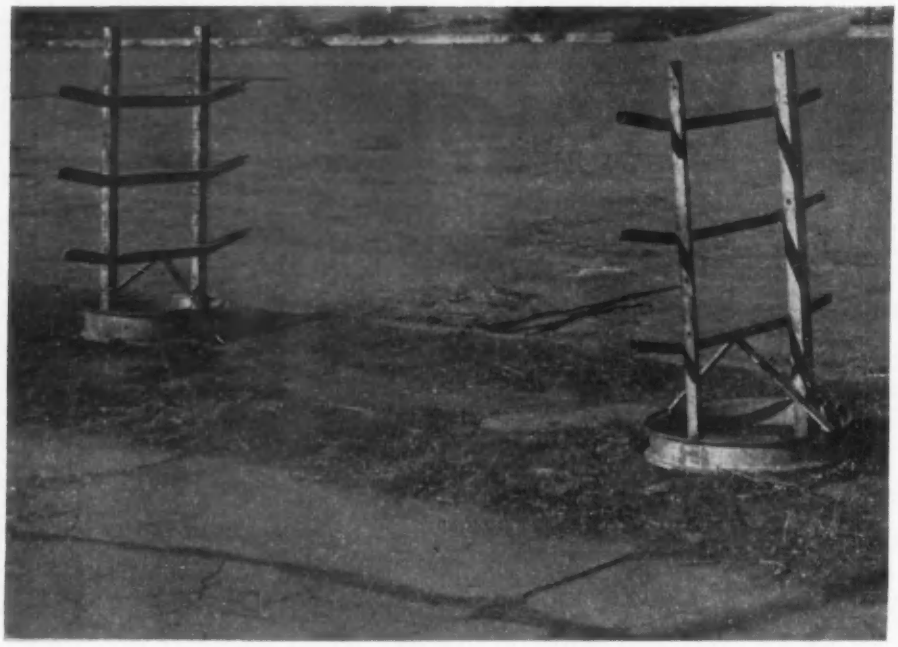


Rack Keeps Small Pipe Handy

A rack to keep small diameter pipe neatly stacked may be fabricated at very little cost. The rack is made from tire rims and scrap iron as shown in the illustration.

The discarded tire rims serve as a base for each rack. Two vertical members, welded to the inside of the rim, carry the weight of the stacked pipe. Scrap angle iron or channels welded at 18-inch intervals support the lengths of pipe. To prevent the pipe from rolling off the extended arms of the cross members, the outside ends are bent upward at an angle of about 5 degrees.

Braces of scrap iron welded to the bottom cross member keep the tire rim at right angles to the vertical posts and provide needed rigidity. Racks are stable because of their low center of gravity. They are light and can be moved from place to place.

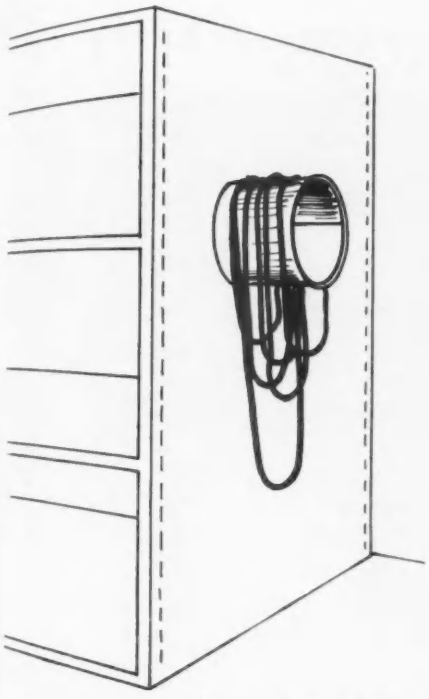
Extra Can Provides Hose Storage in Shop

If welding hose, extension cord or garden hose always seem to end up in a tangled mass around the shop, make a reel for them similar to the one shown in the illustration. This device is merely a can bolted to a locker wall.

The can may be any size from one to five gallons, depending on needs. Fasten it to the wall by drilling holes through the bottom of the can and through the wall and bolting the two together. Place large washers on the head of the bolt to help distribute any weight placed on the can by the hose.

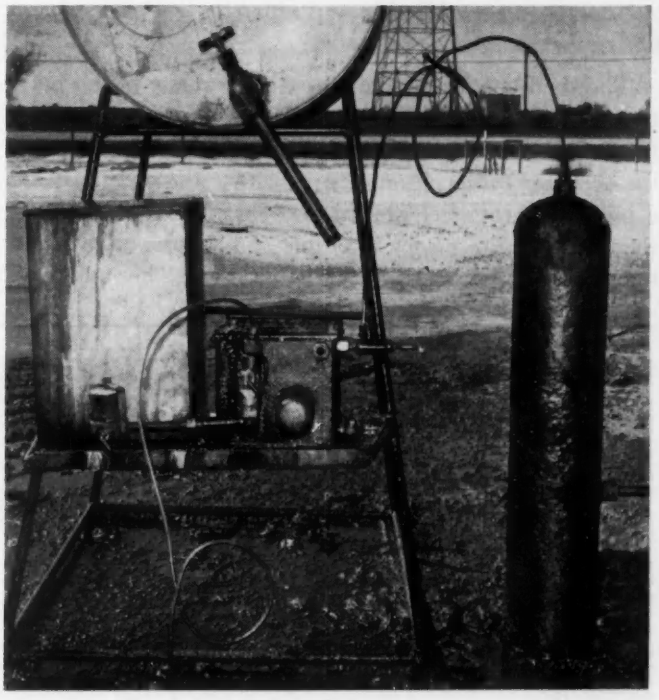
To provide a storage place for noz-

"Otis... First in Pressure Control"



zles, washers or other equipment used with the hose, cut the lid of the can in half and place it back on the can as illustrated. To avoid injury, fold the cut edge down out of the line of reach.

Make Inhibitor Injection System in Shop



An effective inhibitor injection system, with the exception of the pump, can be shop-made. The volume tank, to which the gas flow line connects, is made of a piece of casing with an orange peel weld at each end. A length of tubing runs from the volume tank to the small pump which injects the fluid into the well.

The barrel containing the inhibitor is supported by a frame made of old sucker rod which can be driven into the ground for additional stability. The galvanized iron measuring tank supplying the pump is fitted with a lid which

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$750,000.00 Oil Well Protected Against Wild, Uncontrolled Flow For Less Than 1/10 of 1%

24 hours a day dependable Otis "Storm Chokes" protect your wells in case of emergency. If you are operating oil or gas wells near highways, schools, or townsites, or in rivers, lakes, canals, or off-shore locations subject to seasonal storms, install an Otis Tubing Safety Valve *before* you need it. Then if the rate of flow increases above a predetermined amount, this reliable safety device will *instantly* snap to a positive shut-off to close in the well *below the surface*.

The cost of the "insurance" an Otis Safety Valve will afford your production will both surprise and please you. A call to the nearest Otis office will bring you complete details, illustrated literature, and a recommendation as to the specific type of Otis Safety Valve for your particular wells. For full details and expert engineering consultation without obligation, contact your nearest Otis office.

OTIS PRESSURE CONTROL, INC.

OTIS STORM CHOKES

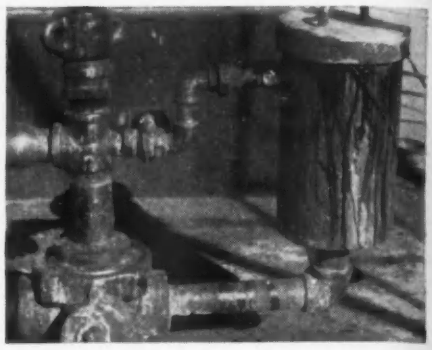
swings back to allow the spout from the barrel to be rotated into position above the tank.

The shelf containing the pump and the tank is an integral part of the frame. The front and rear parts of the shelf are one-inch angle iron with a piece of sheet steel welded between them. The entire device is simple and inexpensive.

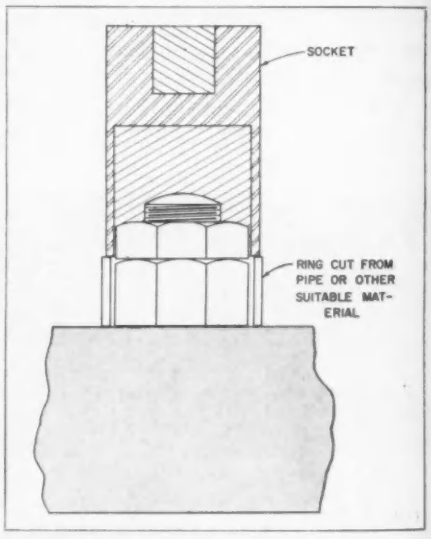
Rig Mixing Pot for Corrosion Inhibitor

In using corrosion inhibitors it is advantageous to circulate production down the annulus with the chemical. One means of accomplishing this is by running a pipe from the flow line or pumping T to a mixing pot like the one illustrated. The mixing pot is then, in turn, connected to the annulus allowing the fluid to circulate.

The quantity of fluid allowed to flow is controlled by a small valve placed in the pipe between the flow line and the mixing pot.



This mixing pot is made from a piece of casing with a plate welded on the bottom. This plate is drilled and threaded to accommodate the flow line to the annulus. The lid illustrated is loose fitting and made from casing and steel plate.



Metal Ring Eases Lock Nut Removal

Lock nuts on main bearing caps of large engines and other equipment around the rig are often in locations difficult to reach. To save time and labor during overhaul, one maintenance crew cut a ring from pipe just large enough to slip over the bottom nut and high enough to cover the flats as shown.

The ring lets the socket wrench fit down over the lock nut just far enough to remove it. When the wrench turns it will loosen the lock nut only. Thus, lock nuts are removed quickly and easily with one wrench.

THE ENARDO VAPO-GARD* THIEF HATCH VALVE IS GROWING GROWING GROWING

The new Vapo-Gard "by-pass" hatch valve closes the vent line for better vapor control when the hatch is opened.

Vapo-Gard Thief Hatch Valve Series 770-BP

The enthusiastic acceptance of our original Vapo-Gard thief hatch valve is largely due to the pressure energized gasket which proved to be long lasting in all oils and oil vapors. This same gasket compound and principle is being used in the construction of the Vapo-Gard valve, adding to the durability and vapor sealing qualities of the new valve.

The Vapo-Gard valve with "by-pass" is constructed of rigid high strength pressed galvanized steel on a cast meehanite metal base.

*Reg. T. M.

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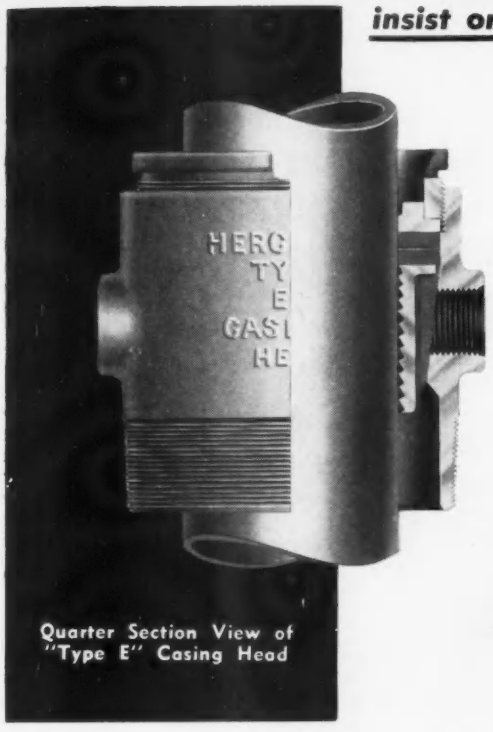

Quarter Section View of "Type E" Casing Head

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Constructed from pressure cast steel and hydrostatically tested to 3000 psi. Pack-off is accomplished with Hercules ORIGINAL OVERHEAD PACKING. The three-piece hinged slips insure even gripping action and facilitate installation. All sizes are full-opening, allowing passage of centralizers, packets, etc. The packing nut acts as a thread protector and is provided with notches to accommodate a wrench or pinch bar. The recommended maximum load is 200,000 lbs. Write for complete information and range of sizes.

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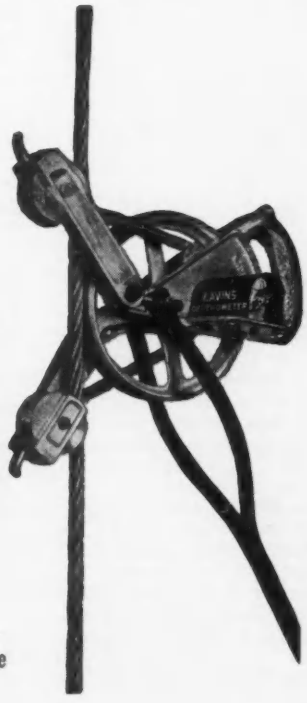

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What's Happening

AMONG MEN IN THE INDUSTRY

Howard D. Henderson, manager of **Sohio Petroleum Company's** Gulf Coast division, recently was appointed coordinator of foreign operations. He will assist Rudolph W. Edmund, assistant to the vice president in charge of exploration. The company now has operations in Guatemala, Venezuela and Iran. Henderson will be located in the Oklahoma City headquarters of the company.

•

George V. Myers, recently appointed general manager of production for **Standard Oil Company (Indiana),** has been financial vice president and a director of Stanolind Oil and Gas Company at Tulsa. He assumed his new duties in Chicago March 19. Myers will coordinate production and crude oil supply activities of Standard Oil with operations of such subsidiaries as Stanolind Oil and Gas Company, Service Pipe Line Company, Stanolind Oil Purchasing Company and Tuloma Gas Products Company. He joined Stanolind in 1953 as manager of the financial departments and a director of the company. Later that year he was elected to a vice presidency. In two other appointments announced by Stanolind, **F. Cushing Smith** was advanced to the new position of assistant to the president; and **O. J. Glasman** was promoted to assistant manager of the Organization department. Smith joined Standard Oil in 1943 as a chemical engineer at Whiting. In 1947 he was transferred to the company's general office at Chicago as technical assistant in the manufacturing department, and in 1953 moved to the Whiting refinery as general foreman on special assignment. He later advanced to assistant superintendent. Glasman started with the company in 1924 as assistant cashier. He was named administrative assistant in the office of the executive vice president at Chicago in 1952, and has been administrative assistant to the president since 1955.

George V. Myers

•

Prentis Cobb Hale, Jr., chairman of the board of directors of Broadway-Hale Stores, Inc., was elected to the board of **Union Oil Company of California** recently. In addition to chairmanship of Broadway-Hale Stores, he is president of Hale Brothers Realty Company; director, Pacific National Fire Insurance Company; and member of the Advisory Committee of the Bank of America.

•

Harry E. Allen, Northern division engineer for **The Carter Oil Company** in Billings, Mont., is joining the Carter production staff in Tulsa as special projects engineer. He has been with Carter since 1941 in various engineering capacities in Tulsa, Seminole, Purcell, Oklahoma City, Okla., Great Bend, Kansas, and Billings. **George Link,** a member of Carter's engineering staff in Mattoon, Ill., has been named Northern division engineer to succeed Allen. **J. D. Simmons** will replace Link at Mattoon, and **Joe H. Norman** becomes district engineer at St. Elmo, replacing Simmons. Link began his Carter service in 1947 and has worked for the company in Tulsa, Mattoon, and Carmi, Ill., and Denver. Simmons has been with Carter since 1948 in Tulsa and St. Elmo. Norman, since 1949, has been working in Mississippi and Arkansas.

•

The El Dorado Refining Company announces the appointment of **James R. Hamilton** to head its Exploration office in Denver. He replaces **Max S. Houston,** recently named manager of all the company's geological and exploration activities. Hamilton has a background of geological experience in the Rocky Mountain area, as well as in the southern states and South America. Houston, who will be in charge of all land and lease, geological and drilling activities for Elreco, has been with the company since 1951. For the past year he has been in charge of the Denver exploration office.

•

Arkansas Fuel Oil Corporation has announced the addition of **A. H. Weyland** to the staff position of consulting engineer. He has been in the oil and gas business of the South and Southwest as an engineer and executive many years.

•

Rex Shaver was elected president and three others were elevated to official positions in **H. L. Rowley, Inc.,** drilling contractors headquartered in Shreveport, by recent action of Rowley directors. **Stephen Rowley** was named vice president; **Carl G. Kendrick,** secretary-treasurer, and **W. H. Son,** drilling superintendent. Shaver, who has been executive vice president of H. L. Rowley nine years, formerly served in the production department of The Texas Company. Son of the founder, Rowley joined the drilling contracting firm in 1953, serving as assistant to the president and directing public relations and the safety program. Promoted from assistant secretary-treasurer, Kendrick has been a member of the Rowley administrative staff six years. Son, who has been a toolpusher in the Rowley organization since 1948, will direct drilling operations from the company's general offices at Shreveport.

Rex Shaver

Archie D. Gray, general counsel of Gulf Oil Corporation, has been appointed a member of the American Petroleum Industries Committee of the American Petroleum Institute. He succeeds **David Proctor,** executive vice president and a director of Gulf Oil, who resigned from the Committee in February after serving since 1944. Gray has been with Gulf Oil since 1935 when he joined the corporation's law department in Houston. In 1947 he was appointed associate general attorney for Gulf and in 1953 was transferred to the corporation's general office in Pittsburgh. He was named Gulf's general counsel February 1.

Archie D. Gray

•

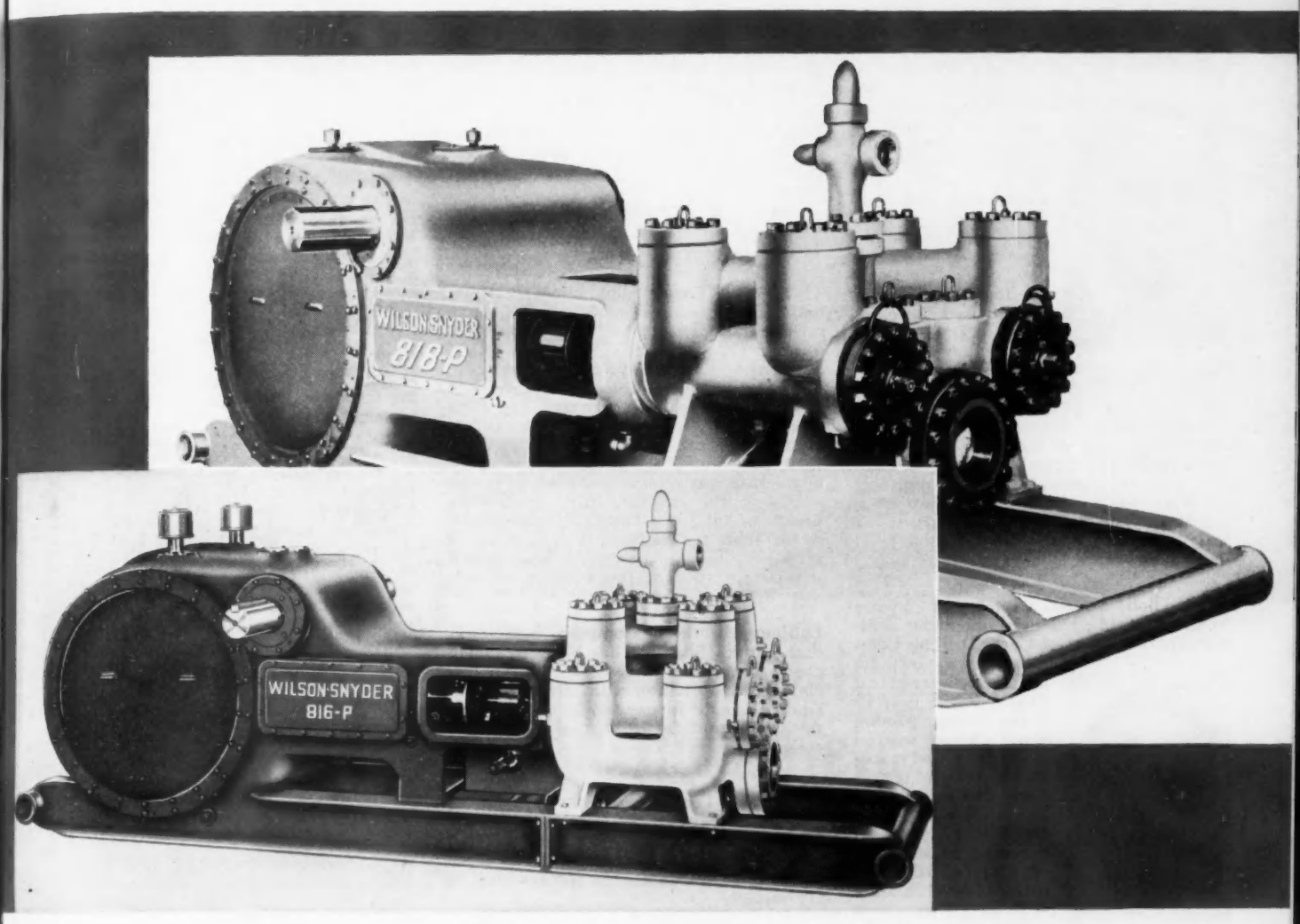
Continental Oil Company announces the promotion of two men to new positions in the Production department. **Rufus M. Smith,** promoted to manager of production for Conoco's western region, formerly was a member of the western region exploration staff. He will continue to make his headquarters at Los Angeles. **Glen F. Gibbins,** promoted to superintendent of the Denver City, Texas, production district, formerly was production foreman at Eunice, N. M. He succeeds **Frank Elliott** who recently transferred to Abilene, Texas, as district superintendent. Smith joined Conoco in 1948 as a geologist in California, transferring to Houston in 1953 as director of training for the production department. He returned to Los Angeles as a member of the company's exploration staff the following year. Gibbins joined Conoco in 1953 at Eunice and held a succession of production positions at that location before his promotion to production foreman in 1955.

•

Robert B. Rice has been appointed senior research physicist in the physics section of **The Ohio Oil Company's** Research Center under construction in Denver. From 1945 to early in 1956, he was on the research staff of the Phillips Petroleum Company, Bartlesville, and taught graduate extension courses in mathematics for Oklahoma A&M College.

•

Herman P. Taubman, founder and president of **Buffalo Oil Company,** recently was named chairman of the board and chief executive office. Succeeding him as president is his son, **Morris B. Taubman,** who has been executive vice president. **W. W. Lomerson,** former assistant to the vice president, was named vice president and will continue as manager of the southern region. Both Morris Taubman and Lomerson will maintain present offices in Fort Worth.



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John C. Askam, former chief safety engineer of **Ohio Oil Company**, has been appointed assistant to the vice president of administrative services. He will serve as liaison with the military in the capacity of security officer for the company, and will be responsible for investigating all factors pertaining to the protection of company property and developing plans to be followed in cases of emergency. **H. C. Walker** has been appointed acting supervisor of the Safety department in addition to his responsibilities as assistant manager of the Personnel department. Askam joined Ohio Oil in 1916, working in Kentucky, the old Illinois field, the company's eastern pipe line division and in the general office as a petroleum and safety engineer. He later was appointed safety director and chief safety engineer.

John C. Askam

•

W. B. (Bob) Stuard, a veteran of 25 years in the oil fields, has been appointed drilling superintendent of **Coral Drilling Company**, new offshore drilling contracting firm. For the past 12 years before joining Coral, Stuard worked in offshore and marsh water drilling operations. His offices will be in New Orleans. In Mobile, Ala. supervising construction of Coral's offshore drilling vessel is **Harvey B. Elder**, new drilling engineer. In oil field work since 1949, Elder joined Texas Crude Oil Company in 1954, transferring to Coral Drilling Company in October, 1955.

Harvey B. Elder

•

Robert A. Harris recently resigned from the staff of Ralph E. Davis, consultant, to join **Starr Oil & Gas Company** in Houston. In his new position he will manage geological activities of the company.

•

Plymouth Oil Company has announced the employment of **L. J. Autin** as regional geologist in New Orleans. To accept the position, Autin resigned as geologist for Gulf Refining Company where he had been employed since 1951. Prior to that time, he was with Louisiana State Geological Survey and Tomlinson Geophysical Service.

•

Pan American Production Company announces the promotion of **Arrice T. Teague, Jr.**, from senior geologist to district geologist in charge of the Shreveport district covering East Texas, north Louisiana and southern Arkansas. Headquarters are in Shreveport. Teague has been with Pan American since 1950. The transfer of **C. G. Henderson**, district production foreman, also has been announced. He will move from the Valley district at Lyford, Texas, to the Central Louisiana district with headquarters at Easton, La. Henderson has been with the company since 1948. **J. A. Short, Jr.**, has been promoted from senior production engineer in the Central Louisiana district to district production foreman at Lyford replacing Henderson. Short has been with Pan American since 1950.

•

Donald I. Gahagan has resigned as research geologist for Pan American Production Company to join **C. N. Housh**, Houston. Prior to joining Pan American, he had been with Skelly Oil Company, George F. Getty, Inc., and Midwest Refining Company.

•

Thomas J. Freeman and **James F. Hartnett** recently were promoted in the public relations department of **Tide Water Associated Oil Company's** New York office, Eastern division headquarters. Freeman, former editor of the division employe publication and winner of the Freedoms Foundation's George Washington Honor Medal in 1955, was named public relations assistant. Hartnett, formerly editor of the company's dealer publication, is now editor of the employe paper, replacing Freeman. In Tide Water's Safety department, **John H. G. Boer**, a veteran of 34 years with the company, has been named safety supervisor of the Eastern division.

•

Loffland Brothers Company announces that **Horace Shumate** has been appointed contract representative of the West Texas-New Mexico division with offices in Midland. Shumate formerly was employed in the production department of a major oil company in West Texas.

•

George H. Fentress recently resigned as district geologist in the Denver Basin from Lion Oil Company to accept a position with **Baumgartner Oil Company** as manager of exploration. His offices are in Denver.

•

Walter C. Holloway, staff official of **Kin-Ark Oil Company**, is a newly-elected member of the company's board of directors. The announcement was made following the first annual stockholders meeting. Previously employed by the former Lawton Oil Company in Magnolia, Ark., and the Murphy Corporation, oil firm of El Dorado, Holloway joined Kin-Ark in November, 1955.

•

Stephen L. R. McNichols, lieutenant governor of Colorado, has been named a director of **Seaboard Oil and Gas Company.** With a wide background of experience in the uranium field, he has served as a member of the executive committee and as legal counsel of the Uranium Ore Producers Association. He also is a member of the board of directors of Mid-Continent Uranium Corporation and one of the founding officers of the Uranium Institute of America.

•

C. A. Lehnertz, Jr., resident geologist for Colorado Exploration Company two years, has resigned to join the staff of **Doeringsfeld, Amuedo and Ivey**, specialists in photogeologic evaluations. Headquarters will be in Denver.

•

S. Russel (Pat) Casey, Jr., announces the opening of offices as petroleum consultant in the Bankers Mortgage building in Houston. He will specialize in appraisals, geology, exploration and operational analysis.

Shell Oil Company's appointment of **Jack Whitehouse** to the public relations staff in charge of press relations has been announced. Whitehouse, who replaces **William Hoyt**, now heading Shell's public relations activities in Tulsa, will be assigned to the Los Angeles office. Whitehouse has edited a number of weekly newspapers in the area, and for two years was in the public relations office at U.C.L.A. He was managing editor of newspapers in Yuma, Ariz., and associated editor of Desert Magazine. In 1955 he worked with national public relations accounts as a free-lance agent before joining Shell Oil in 1955.

•

Paul E. Nicholls, Jr., has been named market research director of **Gulf Publishing Company**, Houston. Nicholls has been serving as maintenance and design editor of PETROLEUM REFINER, nationally-known Gulf monthly magazine. His new position will coordinate the research activities of Gulf's three business papers, which also include WORLD OIL and PIPE LINE INDUSTRY. Before coming to work for Gulf Publishing, Nicholls had extensive experience in engineering-design work with M. W. Kellogg, C. F. Braun and General Electric companies. He received his education at Texas A. & M. College, where he majored in mechanical engineering.

Paul E. Nicholls, Jr.

•

W. R. Newman, consulting geologist, announces the opening of an office in Toronto, Ontario. He also will retain his office in the Mercantile building in Edmonton, Alberta.

•

Richard L. White recently was promoted to senior research chemist at the field research laboratories of **Magnolia Petroleum Company** in Dallas. He is continuing his assignment of obtaining analytical data on the many products resulting from the in-situ combustion recovery field tests made near Comanche, Okla.

•

John H. Wents, Jr., has been named assistant general manager of **Tide Water Associated Oil Company's** Central division, with headquarters in Tulsa. He succeeds Charles R. Brown, recently advanced to general manager of the Central division. Wents transfers to Tulsa from Tide Water's Western division in San Francisco.

•

F. H. Clements has been named field superintendent at **Stanolind Oil and Gas Company's** Yates area at Iraan, Texas. Hired as a roustabout at Pampa, Texas, in 1946, Clements was promoted to junior engineer, petroleum engineer, field engineer, senior petroleum engineer and then production foreman at Yates, the position he held prior to his latest promotion.

•

Charles B. Reed has resigned as chief engineer for Newmont Oil Company to engage in general consulting practice with headquarters in Austin, Texas. An independent geologist in the Mid-Continent area ten years, he also at one time was supervising seismologist for Shell Oil Company.

Thirty-foot lengths of 2-inch, Schedule 40 National PVC Plastic Pipe. Each of these easy-to-handle lengths actually weighs less than 20 pounds.

2,800 feet of
USS NATIONAL* PVC PLASTIC PIPE
laid in 1¾ hours

The TXL Oil Corporation is putting National Polyvinyl Chloride Plastic Pipe to its first rough oil field test—as a gathering line subject to paraffin deposits. A pipe laying crew made the installation in the Permian Basin, 12 miles south of Odessa, Texas, laying the 2,800-foot line in less than an hour and 45 minutes.

Normal impact, two-inch, plain-end pipe was used. Fittings were attached by solvent cementing. The 90 lengths of pipe were coupled at the rate of almost a joint a minute.

* * *

National Polyvinyl Chloride Plastic Pipe is available in two types, in sizes ½″ to 6″ inclusive and in Schedules 40 and 80.

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Nontoxic, the pipe resists deterioration from sunlight, fungi, bacterial action and soils. Its smooth internal surface offers low flow resistance.

For further information on USS National Polyvinyl Chloride Plastic Pipe, send for Bulletin No. 24. Write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

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MIDLAND
Luccous Service & Equipment Co. ---------- 2-1631
PETTUS, TEXAS
Eddie Jones Engineering Co. -16 or Beeville 1547
OKLAHOMA CITY
Rainbo Service Co. ---- ME 4-2131, ME 2-3045
LIBERAL, KANSAS
Rainbo Service ---------- Main 4-3598
WICHITA FALLS
Hudson-Eads, Inc. --- 2-3767, 2-8584, 3-4690
CASPER, WYOMING
C. A. White ---------- 3-5264
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C. A. White ---------- EMpire 5-3833
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World Oil Editorial Dept.
P. O. Box 2608 - Houston, Texas, U. S. A.

John G. McLean, authority on industrial organization, has been elected a vice president of **Continental Oil Company.** He has been with Continental as a part-time consultant since 1948 and during the past 18 months has served as assistant to the president while on leave of absence from the Harvard Business School. In his new position, he will be in charge of coordinating and planning activities for Conoco. He will continue to make his headquarters in Houston. At Harvard, where he was professor of business administration, McLean was engaged in teaching and research in the field of industrial management for approximately 15 years.

John G. McLean

•

David J. Kull is now exploration manager for **Shell Oil Company's** Kansas division, succeeding **Alfred N. Sharrick** who is being transferred to Midland, Texas. Kull joined Shell in 1948 as a junior geologist. He served in various assignments with steady advancements in Kansas and Colorado, and in 1954 was promoted to exploration manager of the company's Colorado division. Sharrick has spent the past 15 years in Kansas. Now division exploration manager, he is a Shell veteran of nearly 20 years.

•

Humble Oil & Refining Company has announced the following changes in its Production department supervisory personnel. **W. W. Thames,** formerly district superintendent at North Katy, was transferred to the Anahuac district as assistant district superintendent, replacing **J. H. McReynolds,** who transferred to the Goose Creek district as assistant district superintendent. **W. L. Hooks,** formerly district superintendent at Livingston, moved to the Hardin district as assistant district superintendent. **F. A. Keilberg,** formerly farm boss at North Katy, transferred to Tomball district as farm boss; **R. H. Suman,** district petroleum engineer at North Katy, transferred to Maurbro district as district petroleum engineer; and **P. L. McGee,** district petroleum engineer at Livingston, transferred to Raccoon Bend district in the same capacity. **C. E. Claborn,** farm boss at Livingston, transferred to Hardin as farm boss. Roustabout gangpushers **J. H. Parish, E. E. Sojourner,** and **I. P. Smith** of Livingston transferred to Hardin, and roustabout gangpushers **Lonnie McIlvain** and **Harold Neeley** transferred to Tomball. **L. W. McClure,** gas plant repairman, 1st, Lovell Lake district, was promoted to mechanical supervisor at Thompsons district, Gulf Coast division; and **Lehman H. Harris,** welding inspector, East Texas division office, transferred to the Means district, Western division, as welding inspector.

•

S. R. Cross has been promoted to assistant regional geologist for **Continental Oil Company's** central region, with headquarters in Oklahoma City. Formerly division geologist at Wichita, he succeeds **P. R. Warren,** recently promoted to regional geologist. Cross joined Conoco in 1946 and served as a geologist in Oklahoma and Kansas before his promotion in 1952 to division geologist at Wichita.

E. Floyd Humphries has been named assistant chief geologist, working with Clare Clark, chief of the Geology division for **Texas Illinois Natural Gas Pipeline Company** and its affiliate, Natural Gas Pipeline Company of America. **Edwin A. Allen,** formerly office manager for the Houston location, has been appointed assistant superintendent of production under C. R. Worst. Replacing Allen is **Albert G. Petzold,** who was administrative assistant to Vice President of Operations Mark V. Burlingame in company headquarters, Chicago. Humphries joined the company in 1954 and has been active in offshore exploration of the companies. Starting with Texas Illinois in 1950, Allen was promoted to office manager in 1953. Petzold, who assumed his duties as office manager April 1, will complete ten years' service with the company this year, having worked in the Engineering, Construction and Operations division as well as at the compressor station of the affiliate pipe line company.

•

Davis Bros., exploration consultants, announce that **Ralph A. Hockenson,** registered professional engineer, is now a member of the firm. He is available for consultation on matters pertaining to evaluations, secondary recovery projects, mergers, consolidations and other engineering problems. His offices will be in the firm's headquarters in Tulsa.

•

William B. Macey, former director of the New Mexico Oil Conservation Commission, and geologist for the State of New Mexico, joined **Western Development Company** recently as a vice president. Formerly with the American Republics Corporation as district superintendent and the New Mexico Oil Conservation Commission as chief engineer, he was appointed director of the Commission and, also, geologist for the state in 1954.

W. B. Macey

•

W. E. Dermody, director of advertising for **Gulf Oil Corporation,** has retired after 22 years with the company. Dermody joined Gulf in the general office in Pittsburgh in 1934 as manager, specialties sales, and was responsible for the development of advertising, promotional and merchandising programs for petroleum specialty products. In 1949 he was named director of advertising, responsible for all of Gulf's newspaper, billboard, radio, television and other advertising. **B. W. S. Dodge** has been appointed director of advertising for Gulf, succeeding Dermody. Dodge has been supervisor, retail layout and copy, in the company's Advertising department; in his new position he assumes direction of all of Gulf's advertising. He first joined the company in 1938 as an advertising copywriter and served in that capacity until 1946 when he left to join Bond & Starr, Inc. He remained there until 1948 when he rejoined Gulf as administrative assistant to the director of advertising.

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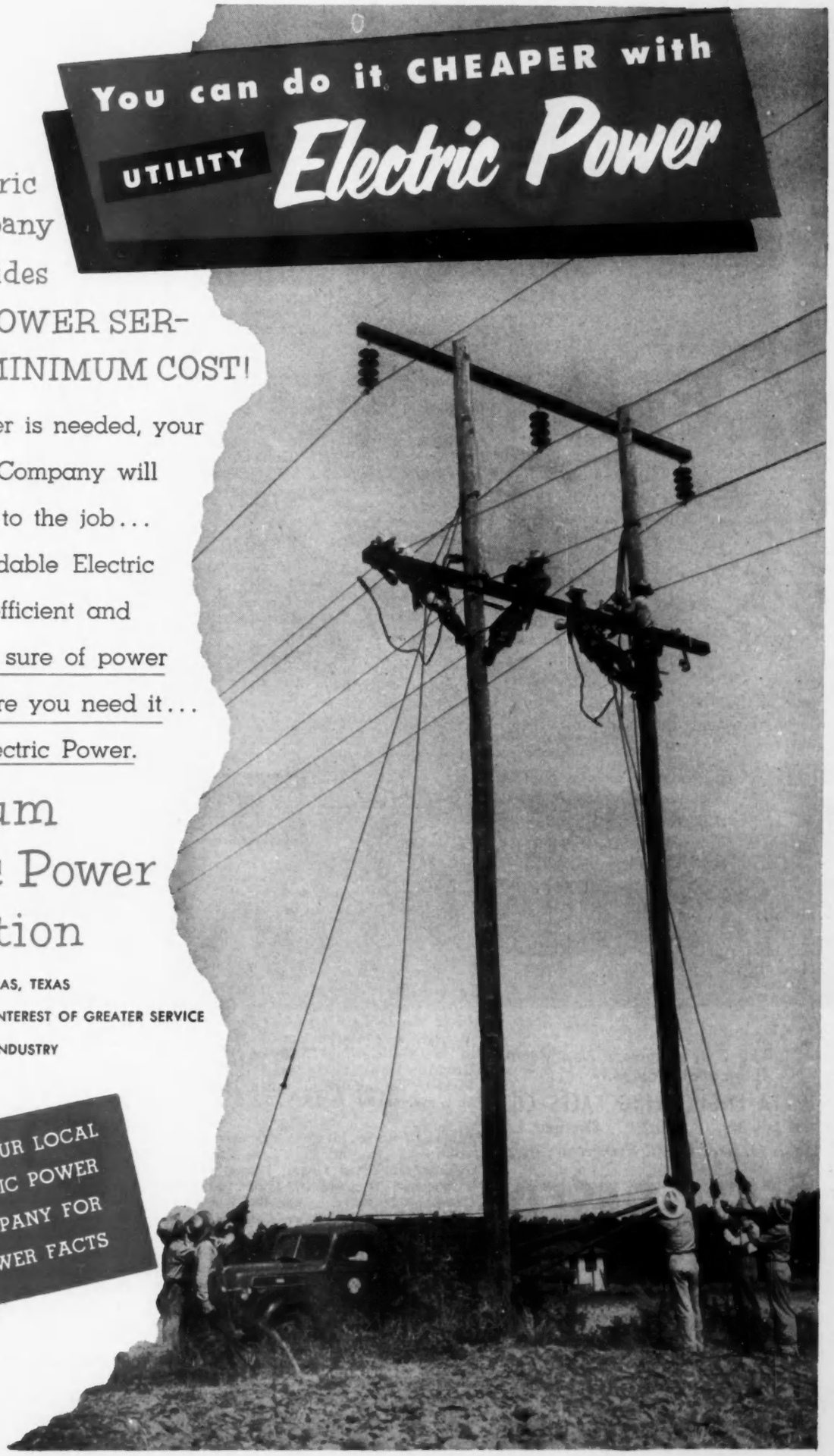

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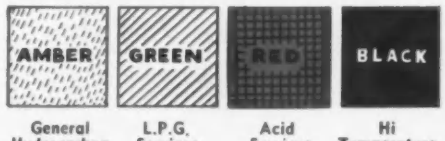

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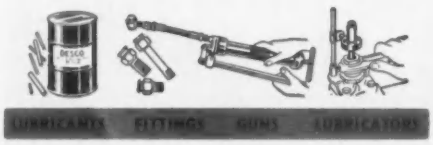

Frederick L. Stead has announced his resignation as Western division exploration manager of Ada Oil Company to accept the position of chief geologist with **McAlester Fuel Company** of Magnolia, Ark. Stead opened Ada's Midland, Texas, offices two years ago. Prior to this he was district geologist with Continental Oil Company in Midland and an instructor on the faculty of the Geology department at the University of Texas. He taught micropaleontology and subsurface geology.

F. L. Stead

•

Production Profits, Inc., an oil and gas production, engineering firm, specializing in operating problems, has announced the appointment of **W. M. Thornton** as engineer. Previously with The Atlantic Refining Company as an engineer in the Production department, Thornton, with Production Profits, will specialize in operating problems involved in secondary recovery by water-flood.

•

Steve F. Huston, veteran land man, has been named public relations assistant in the Tulsa office of **The Carter Oil Company.** Huston has been with Carter's exploration department 17 years. For the past ten years he has been Eastern division landman at Mattoon, Ill.

Harvey L. Hurley, former vice president of Great Basins Petroleum Company, recently resigned to become an independent oil operator and producer. His offices will be in the Midland Savings building in Denver.

•

V. L. (Fred) Smith, formerly Oklahoma district superintendent for **Sunray Mid-Continent Oil Company**, has been named district superintendent of the North and West Texas district, Midland; **J. F. Dingee**, formerly assistant superintendent for the Kansas district, has been named Oklahoma district superintendent at Oklahoma City. **E. F. Patrick**, formerly at Midland, is now superintendent of the Production department's Western area operations. **R. R. Rothrock**, formerly Sunray's Osage area superintendent in Pawhuska, has been transferred to Oklahoma City as assistant Oklahoma district superintendent, and **R. E. Wingo** also is an assistant district superintendent at Oklahoma City. **L. A. Prichett**, formerly western area field superintendent in the Oklahoma district, has been named Osage area superintendent at Pawhuska. **Grant E. McClatchey**, formerly assistant district superintendent for Sunray Mid-Continent's South Texas district, Corpus Christi, has been transferred as development superintendent for the North and West Texas district. **A. E. (Gene) Meissner**, formerly field superintendent, Placedo, Texas, has been named to succeed McClatchey as assistant district superintendent, Corpus Christi. **L. L. Peek** is assistant North and West Texas district superintendent.

DEATHS

Ernest James Nicklos, 75, oil industry pioneer, died in Houston April 7. He was chairman of the board of Nicklos Drilling Company and of Nicklos Oil & Gas Company. A former division manager of production for The Texas Company and vice president in charge of production for Continental Oil Company, Nicklos began his career in the oil industry at the age of 16 in the refinery operated by his father in Petrolia, Ontario, Canada. He worked in the Galician oil fields in Poland, in Croatia, Yugoslavia, and in Tampico, Mexico. He became an independent operator in Houston in 1935.

Albert B. Reese, formerly managing editor of WORLD OIL and PIPE LINE INDUSTRY, died March 23 in Austin, Texas, while on a business trip. With Gulf Publishing Company 12 years, he also had had an extensive newspaper career, working on the staffs of the Houston Press, Galveston Daily News, Sherman Democrat and Denison Herald. All are Texas newspapers. He joined the staff of Petroleum Week as senior editor last fall.

Oliver H. Attridge, chief engineer for Lucey Export Corporation, New York City, died recently in Bay City, Texas, while on a business trip. Attridge was chief engineer of Lucey Products Corporation in Tulsa from 1935 until 1940 when he took the New York position.

W. Gilbert Prince, 60, owner of Prince Drilling Company, died recently in Houston. He founded the drilling company in 1941. A native of Garrison, Texas, he had been a Houston resident 19 years.

W. M. Gaston, 59, vice president of North American Geophysical Company, died February 4 in Houston. He was a veteran of 30 years in the oil business.

Joseph Frederick Cook, 81, died February 8 at Coffeyville, Kansas. A drilling contractor for many years in the Bartlesville-Ochelata, Okla., area, he also worked in India and other countries abroad as a drilling instructor.

R. L. Hewitt, chief geologist for Trico Oil & Gas Company, died in Bakersfield, Calif., February 4. Also with Harry H. Magee, operator, for the past seven years, Hewitt previously worked for Western Gulf Oil Company, Tide Water Associated Oil Company and Standard Oil Company of California.

Erret Dunlap, 74, Oklahoma oil man, died February 1 in Ardmore. He was an associate of Jake Hammon and Sam Apple and other early-day oil men in the Healdton field.

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Cameron, the pioneer in multi-zone completion equipment, has now applied the many dependable features of the Closed-Pressure Method to the remarkable "DC" tree for parallel tubing strings. Suspension is completely versatile, permitting any work on either zone independently. Triple seals are the most advanced in the industry. The unique Cameron Non-Lubricated Master Valve employs the famous Lift-Plug components which may be replaced for a complete overhaul without removal from the tree and, of course, require no lubricants. The "DC" tee and caps permit every known operation to be performed with an absolute minimum of work.

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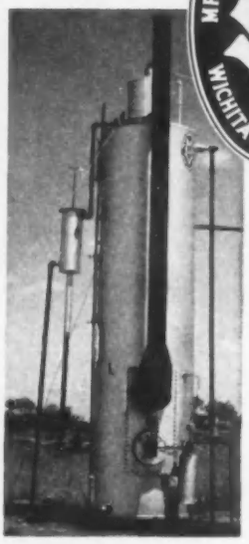

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Companies in the News

CITIES SERVICE OIL COMPANY (DELAWARE) has obtained a uranium exploration lease from Texas National Petroleum Company on the 110,000-acre Canon de San Diego grant in Sandoval County, New Mexico. The grant is 50 miles west of Santa Fe and 40 miles north of Albuquerque. Cities Service is expected to move a uranium exploration crew to the Sandoval County lease soon. This crew is a part of the uranium exploration section of the company's geological department. The section is under the direction of Ernie Tisdale, who will establish an office in Albuquerque. P. K. Hurlbut, Vernon C. Howell and J. H. Drewelow, uranium exploration geologists for Cities Service, already are stationed in Albuquerque.

•

SHELL OIL COMPANY has received four awards from the National Safety Council for an outstanding safety record during 1955. The Greater Los Angeles Chapter of the N.S.C. acclaimed Shell one of the leaders in the field of industrial safety as it presented the oil company with trophies for first place in petroleum production safety, first place in petroleum refinery safety to Shell's Wilmington-Dominguez refinery, perfect record award in the natural gas division, and special award in the field of exploration safety. Receiving the award for the Shell refinery was **P. J. Merkus,** refinery manager. Three Shell men with long-term safety records were chosen to receive the other three awards: **Raymond Strong,** from the Shell Capitan gas plant near Ventura, with a 35-year accident-free record, accepted the natural gas award; **Fred W. Dean,** dynamite shooter for the Salt Lake City division, with a 20-year safety record, accepted the exploration award; and **Claude R. Faust,** head well puller in the Ventura fields, with a 21-year safe driving record, accepted the production award.

•

McCORD OIL COMPANY has been formed by **Charles T. McCord, Jr.,** Shreveport oilman. The new firm, which has offices in the Henry C. Beck building in Shreveport, will specialize in developing oil and gas properties in the Ark-La-Tex area. McCord has been active in the oil industry 20 years.

•

STANDARD OIL COMPANY (INDIANA) plans to consolidate nine of its wholly-owned subsidiaries into four, on functional lines. The program, now in the planning stage, probably will take effect at the end of this year. Changes are expected to include separate consolidations of three chemical, two producing, two pipe line and two refining and marketing subsidiaries: Indoil Chemical Company, Pan American Chemicals Corporation and Hidalgo Chemical Company will become a single company probably with a new name; Pan American Production Company will consolidate with Stanolind Oil and Gas Company; American Oil Pipe Line Company, with Service Pipe Line Company; and Pan-Am Southern Corporation, with The American Oil Company. Subsidiary crude oil purchasing activities will be consolidated in Stanolind Oil Purchasing Company.

R. S. Buckland

W. B. Gallup

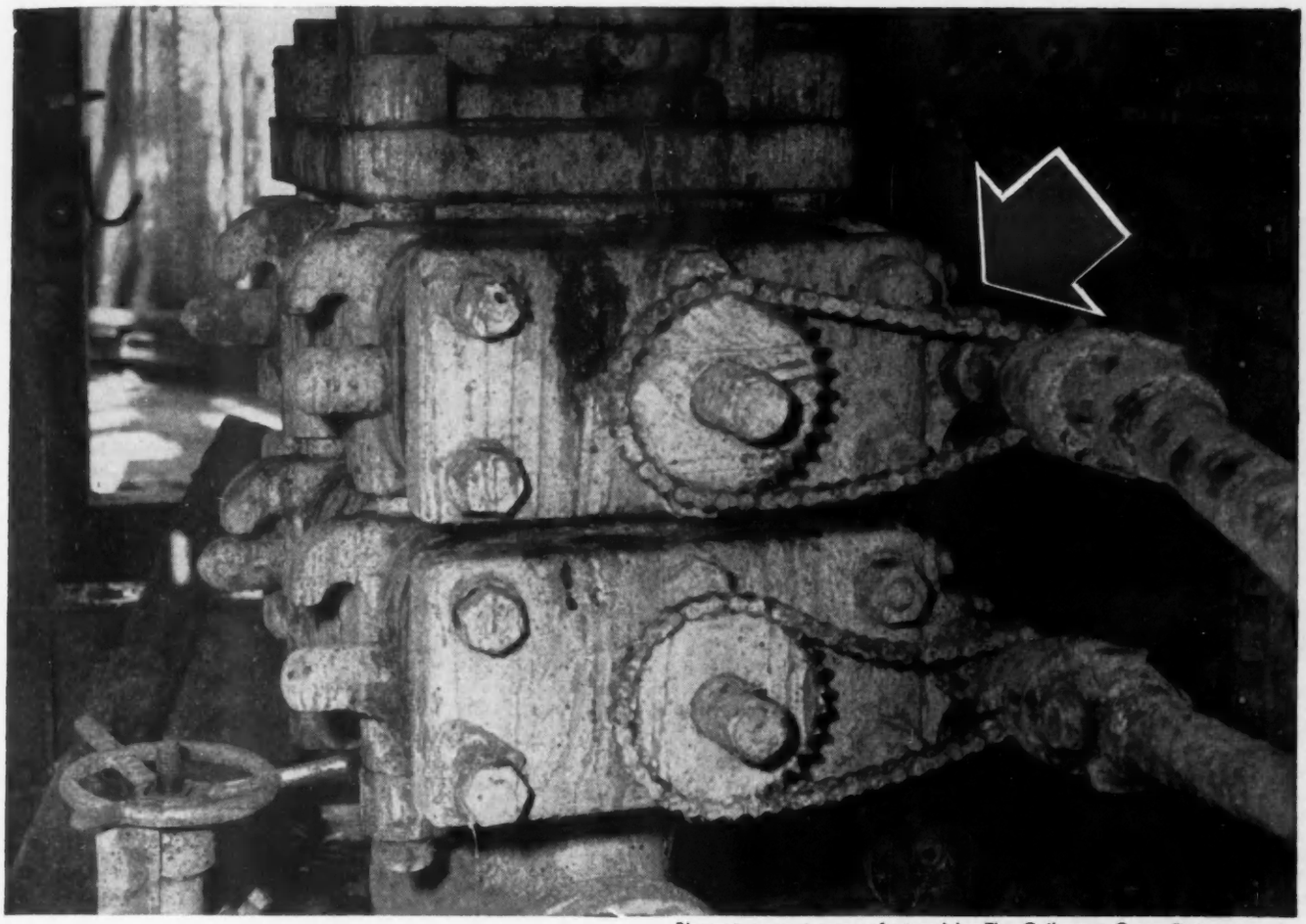
GALLUP, BUCKLAND AND FARNEY, LTD., a new firm of exploration consultants, has opened offices in Calgary, Alberta, Canada. Both geological and geophysical consulting will be offered by the organization; FARNEY EXPLORATION CO. LTD., providing the geophysical arm of the company. **W. B. (Bill) Gallup** and **R. S. (Dick) Buckland,** both formerly with Royalite Oil Company, Ltd., head the new firm. One of the veteran geologists in Alberta, Gallup's undergraduate field seasons during college were spent prospecting and geological mapping in the Canadian Shield area of northern Saskatchewan and the Southern Plains of the province. Prior to joining Royalite in 1942 as a resident geologist in the Turner Valley field, Gallup was with Anglo Canadian Oil Company Limited, the Home Oil Company, Ltd., and the Alberta Petroleum and Natural Gas Conservation Board. Buckland, prior to graduation in 1949, worked underground at Flin Flon. He joined Royalite's Exploration department in 1949 and has been employed in various phases of subsurface and field geology. Recently he joined the Petroleum and Engineering department of that company.

•

SOUTHERN PRODUCTION COMPANY, INC. recently announced that it has acquired Frederic R. Harris, Inc., specialists in marine engineering. Harris already has opened an office in New Orleans; they will furnish The Offshore Company data on wind and wave action, soil conditions, structural strengths, design of new equipment and modification of present equipment. The office in New Orleans probably also will engage in consultant engineering for companies other than Offshore. The Offshore Company, partly owned by Southern Production, operates three mobile drill barges now on location in the Gulf of Mexico under contract to major oil companies.

•

SUN OIL COMPANY will expand its research center at Marcus Hook, Penn., early this spring when construction starts on a second section of main research laboratory. Administrative and technical personnel and research equipment at the company's Norwood, Penn., laboratory will move to the new building, completion of which is scheduled for 1957. Cost of the building and equipment is estimated at $1,375,000. The new section also will house executive offices of the Research and Development department as well as serve as new quarters for the technical library.



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"In West Texas they drill a lot of holes in high-pressure areas. A driller can never tell when a well's going to 'kick,' so he's got to be ready all the time—and his equipment's got to keep coming through in the pinches. That's why we rent blowout preventers with neoprene ram elements. We know from experience that neoprene can really take it.

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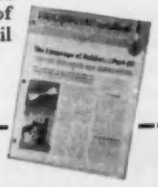

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What's Happening

AMONG INDUSTRY ASSOCIATIONS

Receives AIME Award

Richard C. Durbin recently received an awards certificate from H. DeWitt Smith, president of the American Institute of Mining, Metallurgical and Petroleum Engineers of New York City. Durbin is president of the Petroleum Engineering club and a cadet at Texas A. & M. College. The award was to the A. & M. club, an affiliate of AIME, for having obtained the largest number of student associate members of AIME in 1955 of any school in the U. S. Durbin is a senior majoring in petroleum engineering. The award was presented at the annual spring meeting of the Institute.

Watts Named President Of Texas Oil and Gas Group

Wayne O. Watts is the newly-elected president of the North Texas Oil and Gas Association for the year ending March 31, 1957. He succeeds D. C. Norwood. Other officers named include Ralph O. Harvey, Jr., first vice president; James W. McCutchen, second vice president; and George Anderson, Jr., executive vice president.

Olin Culberson Receives TIPRO Recognition Award

Railroad Commissioner Olin Culberson received the 1956 TIPRO Recognition Award for contributions to the oil industry and for his role in preserving conditions vital to the continued survival and prosperity of independent producers and royalty owners. Presentation was made during the Texas Independent Producers and Royalty Owners Association's recent tenth annual membership meeting in Dallas.

The TIPRO award represents a tribute by independents to that person most deserving on the basis of contributions to independent producers and royalty owners, the industry as a whole, the state and nation.

Judge Culberson, often credited with being the originator of TIPRO, has been a member of the Railroad Commission since 1940.

AAODC Plans Executives Conference

Realistic bidding practices, supervision, communications and good public relations will be topics for round-table discussion at the Conference for Drilling Executives to be held May 9, 10 and 11 at the Baker Hotel in Dallas.

Sponsored by the American Association of Oilwell Drilling Contractors, the three-day program has been arranged with the cooperation of the Petroleum Extension Division of the University of Texas. Four experienced conference leaders will moderate the discussions, with emphasis on individual participation and exchange of viewpoints.

To enable each executive attending to take part in the conference, enrollment in the first session is limited to 30 men, according to Brad Mills, AAODC executive vice president. Mills said the association plans to continue the Executive Conference Series, with similar programs in various localities later.

Coordinator of the Conference is M. L. (Mike) Powers of the University of Oklahoma, who also will lead the sessions on fundamentals of supervision.

Jack Magner, Rowan Drilling Company, Inc., will be conference leader for discussion of communications needed in preliminary research for bidding, between the contractor and his employes and customers.

A conference on "How to bid realistically and get a fair portion of the business" will be led by E. H. Sloyer of R. W. Rine Drilling Company. "Selling your organization" is the conference subject to be led by Eugene Whitmore, independent oil man with background in editing and writing.

Officers, Board Announced By Production Pioneers

Officers of the Petroleum Production Pioneers for 1956, recently announced, are: Honorary president, W. O. Todd, retired drilling contractor and pioneer in rotary drilling; honorary vice president, Ben E. Parsons, retired executive of General Petroleum Corporation; president, Hudson C. Drake, Belridge Oil Company; vice president, Fremont R. Schmieder, Shell Oil Company; and treasurer, Douglas G. Kingman, General Petroleum Corporation.

Sergeant-at-arms is Roland Norris, Macco Corporation; historian, Paul Andrews, Signal Oil & Gas Company; secretary, R. Sneddon; and chairman of arrangements, Tom E. Morton, Halliburton Oil Well Cementing Company.

Eight new directors, elected for a two-year term, are Parsons; C. J. McLaren, Hughes Tool Company; Schmieder; John S. Bell, Humble Oil & Refining Company; Malcolm W. Morris, Standard Oil Company of California; Kingman; W. R. Wiley, McCullough Tool Company; and F. P. Gribbin of Gribbin & Taylor, Bakersfield.

Neighbor to Head AAPG Rocky Mountain Section

New president of the Rocky Mountain Section of the American Association of Petroleum Geologists is Frank Neighbor of Salt Lake City. With Sun Oil Company, he succeeds F. A. (Gus) Thurman, Denver consultant. Dave Moore will be vice president and Walter Quigley, secretary-treasurer. Elections were announced at the end of the group's recent sixth annual convention in Denver.

Darwin Quigley, one of five new state representatives, will represent Utah on the board. Other state representatives are Richard Oburn, Denver, for Colorado; Paul Richards, Billings, for Montana; Otto E. Brown, Durango, for New Mexico; and John Miller, Casper, for Wyoming.

Rocky Mountain Geologists Elect Curtis President

Bruce F. Curtis is new president of the Rocky Mountain Association of Geologists for 1956. Serving with him will be Orlo E. Childs, Phillips Petroleum Company, first vice president; Andrew G. Alpha, Signal Oil and Gas Company, second vice president; and Floyd H. Miller, British American Oil Producing Company, secretary-treasurer. New councilors include Henry H. R. Sharkey, Carter Oil Company, and Daniel S. Turner, consultant.

Carl Reistle Installed As New AIME President

Carl E. Reistle, Jr., Houston, was installed recently as president of the American Institute of Mining and Metallurgical Engineers during the annual meeting in New York City. Reistle is vice president and director of Humble Oil & Refining Company.

Author of many technical papers on oil brines, paraffin problems in crude production and operation of flowing wells, he has been with Humble since 1936, was elected to the board in 1948 and became vice president last year.

Houston Nomads Hear Guest Speaker

At a recent Nomads meeting in Houston, Harold Vance (second from left), vice president of the Bank of the Southwest, discussed problems involved in applying for an oil loan. Among guests present for the talk were (left to right) Jack R. Hamilton, Gulf Oil Corporation, Houston; A. J. Thomson, Mosul Petroleum Company, Iraq; Kraus Earhadt, The Texas Company, Houston; and Jack Ballagh, Tex-Lube, Inc., Los Angeles.

Payne Is 1956 Chairman Of API Southern District

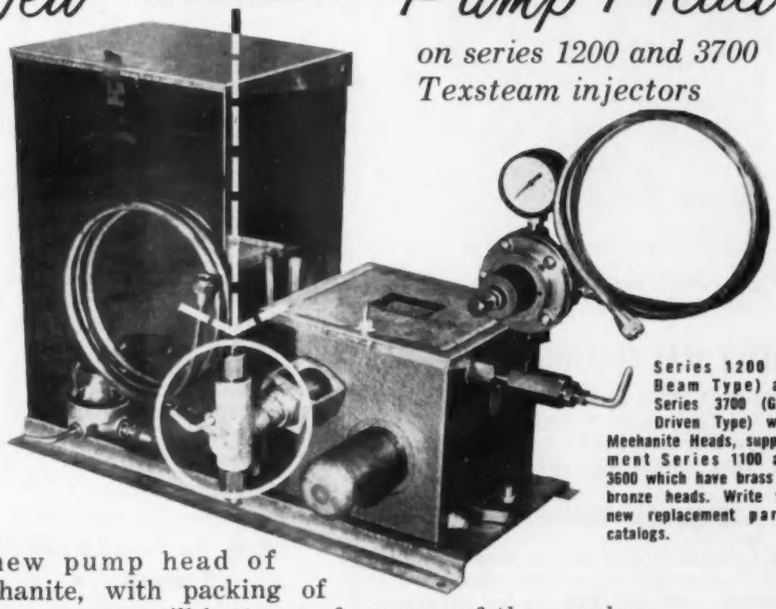
New officers for the American Petroleum Institute, Southern district, were elected recently at the close of a three-day meeting. John M. Payne, Shell Oil Company, Houston, was named new district chairman.

Area vice-chairmen selected were Mike Dillingham, Alice Drillers, for southwest Texas; A. T. Miller, Mobar Mud Company, for southwest Louisiana; W. E. Richards, Rock Hill Oil Company, for the Balcones area; B. C. McCree, Union Producing Company, for Ark-La-Tex; J. F. Roth, The Red Supply Company, for southern Louisiana; Jim Buckley, Sun Oil Company, for Rio Grande Valley; Roy A. Bobo, Phillips Petroleum Company, for Texas Gulf Coast; Bert Crowder, Humble Oil & Refining Company, for East Texas; W. D. Taylor, Schlumberger, for south central Texas; and W. N. Bynum, Hycalog, Inc., secretary-treasurer.

The district covers Arkansas, Louisiana, Mississippi and South and East Texas.

New **MEEHANITE** *Pump Head*

on series 1200 and 3700 Texsteam injectors



Series 1200 (S-Beam Type) and Series 3700 (Gas-Driven Type) with Meehanite Heads, supplement Series 1100 and 3600 which have brass or bronze heads. Write for new replacement parts catalogs.

A new pump head of Meehanite, with packing of Hycar, assures still better performance of the popular Texsteam Chemical Injectors.

The Meehanite head is a special iron casting, designed to withstand practically all compounds commonly used for emulsion breaking and corrosion injection service. It promises years of trouble-free duty.

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DIVISION OF VAPOR HEATING CORP.
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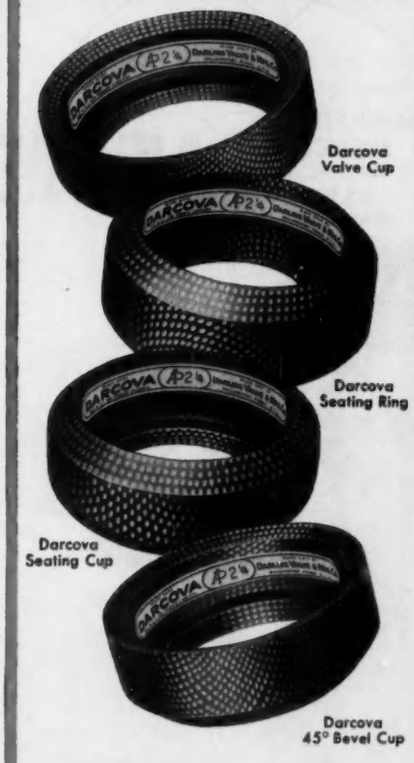

the perfect type and fit for every pumping job!

DARCOVA valve cups and seating rings are available at your supply store to give you unequalled pumping efficiency and economy.

Made in a complete range of types and precision sizes, they also offer you Darcova's unique *texture engineering* that multiplies cup life and minimizes slippage. There's nothing to compare with Darcova performance.

Send for Bulletin No. 5502 and be sure to specify DARCOVA at your supply store.

DARLING VALVE & MANUFACTURING COMPANY

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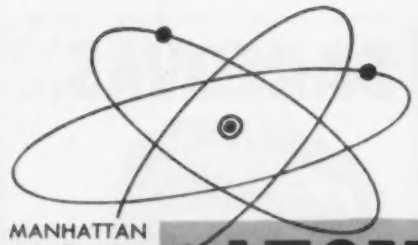
THE ORIGINAL COMPOSITION CUP

WILLIAMSPORT 28, PA.



MANHATTAN PROJECT TO THE U.S.S. SEAWOLF

CATAWISSA PERFECT SEAL UNIONS HAVE HAD A PART IN EVERY APPLICATION OF

ATOMIC POWER

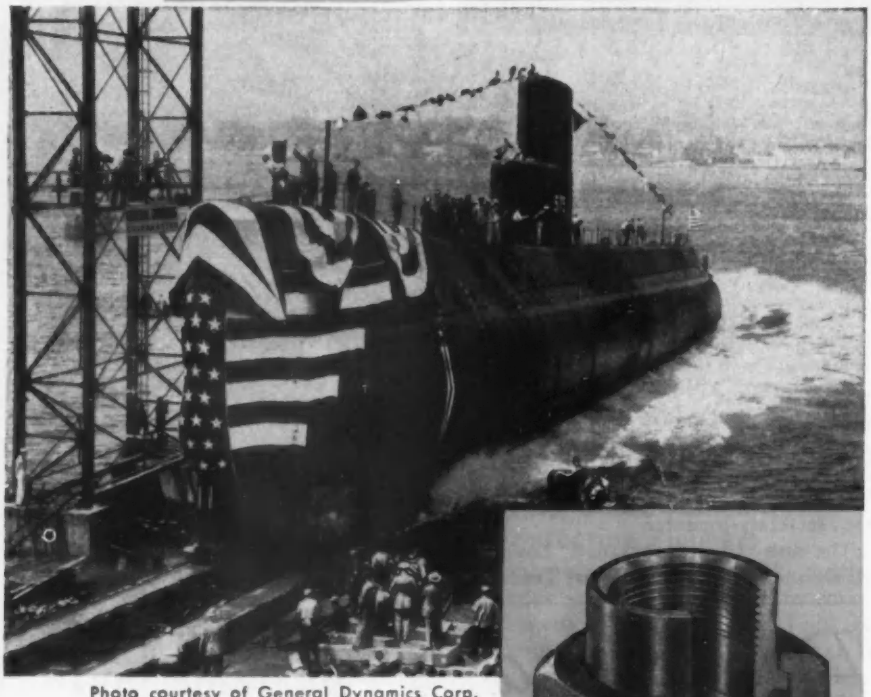
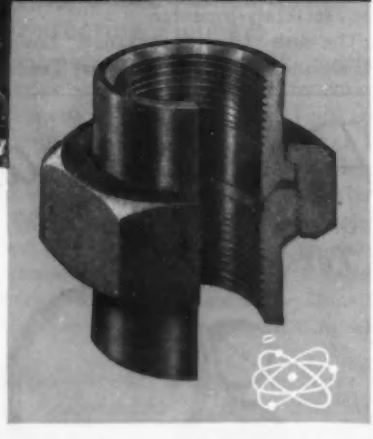


Photo courtesy of General Dynamics Corp.



LAUNCHING THE U.S.S. SEAWOLF at Groton, Conn., marked the development of the second atomic powered submarine built for the U.S. Government. Catawissa Valve & Fittings Co. is proud of its role in the project as major suppliers of Forged Steel Pipe Unions for the "Seawolf" — another repeat order in the atomic field . . . proof positive of satisfactory service!

SAFETY IS A "MUST"

From the original "Manhattan Project" to the U.S.S. Seawolf (and other unannounced atomic developments in private quarters), Catawissa Perfect Seal Pipe Unions have been specified to handle the extreme pressures involved. These are examples of "the toughest jobs", where absolute safety is a "must"!

3-TO-1 SAFETY FACTOR

One of the many extra value features of Catawissa Unions is in the very design itself — a design which gives each union a 3-to-1 safety factor. Catawissa 3000-lb. service unions, for example, are tested to 9000-lbs.; 6000-lb. service unions are tested to 18000-lbs., etc.

This point of superiority, plus expert workmanship and 40 years of experience, make Catawissa Forged Steel Pipe Unions and Swing Check Valves the best buy for rugged, trouble-free service wherever dependable performance is required.

PERFECT SEAL SEATING

Another Catawissa exclusive is its Ball-to-Angle seat design, which assures a Perfect Seal even when the two pipes joined are not in alignment.

ALL PRESSURES, TEMPERATURES

The Catawissa line is the most complete line of unions on the market—regular or special! They're hot forged from solid bars of AISI Spec. C-1026 steel, and meet the requirements of ASTM Spec. A-105, Grade 2.

YOU CAN TAKE THE GUESSWORK OUT OF PIPING PROBLEMS

. . . specify CATAWISSA Perfect Seal Pipe Unions & Swing Check Valves

• AT YOUR FAVORITE SUPPLY STORE •

CATAWISSA VALVE & FITTINGS CO.
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Attend Los Angeles Meeting

International guests at a recent meeting of the Los Angeles Chapter of Nomads were, left to right (standing): Stewart M. Collester, Santa Fe Drilling Company, Australia; Gus J. Jure, D. & E., Dhofar; P. Krijgsman, B.P.M., Indonesia; (seated) Ted Kopp, D. & E., Brazil; Leo L. Goss, Santa Fe Drilling Company, New Guinea; and Herman Rynaard, B.P.M., Indonesia.

W. E. Wrather Awarded Sidney Powers Medal

William Embry Wrather, former director of the United States Geological Survey, has been chosen by the American Association of Petroleum Geologists to receive the Sidney Powers Memorial Medal, highest honor in the science of petroleum geology. The gold medal and scroll recognize distinguished and outstanding contributions to, and achievements in, petroleum geology.

W. E. Wrather

Wrather has received many honors from his profession, including the John Fritz medal, awarded by the four Founder Engineering Societies (1954); the Anthony Lucas Petroleum Medal of the American Institute of Mining and Metallurgical Engineers (1950); and U. S. Department of the Interior Distinguished Service Award (1955). He was made honorary member of the AAPG in 1943; and a life member of the board of trustees of the National Geographic Society in 1951.

Wrather, a founder of the AAPG, served as secretary-treasurer in 1918 and president in 1922.

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. Have you considered writing articles for WORLD OIL or the other technical press? If so, send for our valuable booklet, the Author's Handbook.

Check the square on the convenient Reader's Service postcard opposite the back cover of this issue or send your request for your free copy today to Librarian, Gulf Publishing Company, P. O. Box 2608, Houston 1, Texas.

New Books, Maps and Movies

RESUME OF ROCKY MOUNTAIN OIL AND GAS OPERATIONS FOR 1955, Petroleum Information, 315 North Wolcott Street, Casper, Wyoming.

Oil production, expenditures, wildcat drilling, trends of rotary activity, refineries, geophysical activity and leasing procedures in the oil-producing states are just a few of the topics covered in the 1955 resume of Rocky Mountain area activity. Discovery well reports and statistics on well completions and crude oil production are included in the last two sections of the publication.

Well illustrated with charts and maps, the volume provides a quick reference to various phases of the oil and gas industry in any of the Rocky Mountain states.

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OIL AND GAS FIELDS OF NEBRASKA, Rocky Mountain Association of Geologists, Petroleum Information, 1640 Grant Street, Denver. $15.

This symposium on oil and gas activity in Nebraska includes work of many geologists, consultants, oil companies and the Nebraska State Geological Survey. Designed as a supplement to the volume, "Oil and Gas Fields of Colorado," published in 1954, it provides basic information concerning known oil and gas accumulations in Nebraska, the area contiguous to Colorado and also a part of the Denver basin.

Among special topics covered are pipe lines and refineries in western Nebraska, Cretaceous sands of the Denver basin, quantitative electric log interpretation of "D" and "J" sands, and a resume of production. Also, each field in the state is covered separately. A stratigraphic section of Nebraska by the Nebraska Geological Survey is included, and a structure contour map of the state by E. C. Reed is contained in a pocket inside the back cover.

•

RELIEF MAP OF CANADA, Aero Service Corporation, Philadelphia. $45.

Mountains, valleys and drainage patterns are shown on the vinylite plastic relief map of Canada recently published by Aero Service Corporation. Latest aerophotographic, geographic and geodetic findings have been incorporated into the map and eight different colors represent different types of natural surfaces. Scale of the map is 1 inch to 75 miles; dimensions are 45 by 49 inches. Vertical exaggeration is 20 to 1.

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NATIONAL STRIPPER WELL SURVEY JANUARY 1, 1955, Interstate Oil Compact Commission, P. O. Box 3127, Oklahoma City 5.

This report includes a compilation of data presented in all previous stripper well surveys published to date. The January 1, 1955 survey previously released at the Santa Fe meeting of the Interstate Oil Compact Commission is included, plus tables of each of the items presented annually in previous surveys from 1941. Also included is a map indicating stripper well fields in the U. S.

Production in 1954 from stripper well fields is estimated to be 432,495,896 barrels from more than 340,000 wells. Remaining reserves from stripper well fields have been estimated to be in excess of 3.7 million barrels primary and an additional 3.9 million barrels secondary. Average rate of production for all stripper well fields in the U. S. was 3.48, and ranged from approximately ⅓ barrel per day in Pennsylvania and New York to slightly more than 10 barrels per day in Arkansas. The report points out that increase in production from stripper well fields can be accounted for principally by increase in production from water-flood and gas injection operations.

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THE NEW EXPLORERS, British Petroleum Company, Ltd., 610 Fifth Avenue, New York 20, New York.

Produced by World-Wide Pictures Ltd. of London for the British Petroleum Company, Ltd., this 50-minute color film presents oil exploration in various parts of the world. Not a technical film, it consists of a number of episodes showing oil search in the Persian Gulf, Canada, Zanzibar, Papua, Trinidad and Sicily. The film is available for limited distribution, both in 16 and 35-millimeter sizes, through J. E. Anderson, purchasing agent for British Petroleum in New York.

•

BALL BEARING MAINTENANCE by Johnny Riddle, University of Oklahoma Press, Norman, Okla. $6.00.

This work, basically a shop manual, has been designed especially to aid the consumer in understanding fundamental principles of ball bearing maintenance. In the book, the author includes an explanation of basic bearing types, their variations and expected design changes; a study of unit failures illustrated with photographs; requisites of shop operations and proper methods of handling, mounting and disassembly; shaft and housing modifications or replacement; importance of shaft seat and variations in basic housing designs; special services available through industrial distributing agencies; and principles of lubrication.

Approximately 300 photographs and diagrammatic sketches illustrate the text.

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HIGHWAY GEOLOGY OF OKLAHOMA, Oklahoma City Geological Society, Box 1363, Oklahoma City. $3.25.

This guide book to 4907 miles of Oklahoma highways has been prepared cooperatively by the University of Oklahoma and Oklahoma Geological Survey. Detailed road logs and strip maps describing features of geologic interest highlight the book, with information on oil and gas developments in the state being included.

•

PROFESSIONAL ENGINEERING REGISTRATION LAWS, Alfred L. McCawley, Trustee Publication Fund, Jefferson City, Mo. $8.75.

A synopsis of engineering registration laws of the 48 states, District of Columbia, Alaska, Hawaii and Puerto Rico is included in this newest book edited and published by Alfred L. McCawley. Comparative analysis of 34 critical legal points is presented, and the final chapter has commentary on pertinent Supreme Court opinions.

OIL AND GAS FIELDS IN THE UNITED STATES, U. S. Geological Survey, Distribution Section, Denver Federal Center, Denver. $2.

Compiled by Ann C. Coe, Louis C. Conant and Sophie Drakoulis as of August 1, 1955, this new map of oil and gas fields in the U. S. shows oil and gas fields, oil and gas pipe lines and refineries and principal areas known to have oil shale. Also included is a chart showing geologic ages of producing formations in principal producing areas.

Editions of the map were published in 1932, 1943, 1946 and 1951. The present revised edition is similar in format to the preceding edition. It is printed in several colors on a scale of about one inch to 40 miles.

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PRELIMINARY STRUCTURE CONTOUR MAP OF THE COLORADO PLAINS, U. S. Geological Survey, 234 Federal Building, Tulsa. 50 cents.

Showing the geologic structure of the Colorado Plains, this new map covers an area of about 50,000 square miles east of the Colorado portion of the front range. Mapped structural features include the Sierra Grande and Apishapa uplifts, the Las Animas arch and the Denver-Julesburg and Raton basins.

Prepared by E. A. Finley, C. E. Dobbin and E. E. Richardson, the map is issued as OM 176 of the oil and gas investigation series.

•

PETROLEUM REVIEW, YOAKUM AND TERRY COUNTIES, TEXAS, Phifer Petroleum Publications, P. O. Box 20024, Houston 25, Texas. $10.

A new reference book on West Texas oil production, the Review is the fifth in a series that has covered Andrews, Gaines, Ector and Crane counties. Although Yoakum and Terry counties are included in the same book, the development of each is given separate treatment.

Yoakum County has a history of 23 oil fields dating back to 1936; Terry County has had 20 fields discovered in just ten years. The two counties have been the scene of intensive successful exploration in recent years, and, in view of vast undeveloped areas, could be the scene of still bigger discoveries.

The reference volume has been compiled from field hearing files of the Railroad Commission of Texas. It has 33 illustrations, including structure maps presented as exhibits by operators at the hearings and logs of discovery wells.

•

SOUTH TEXAS STRATIGRAPHIC CROSS SECTION, Corpus Christi Geological Society, Box 1068, Corpus Christi, Texas. $2.50-$5 and $3.50-$7.

The Corpus Christi Geological Society has published a cross section of south Texas from Cameron to Calhoun County, showing faunal, lithologic and electrical log correlations. In two parts, Cameron through Kenedy County and Kleberg through Calhoun County, the cross section also is available complete, showing both halves. Horizontal scale is one inch to 8000 feet; vertical, one inch to 400 feet. Two sizes, also, are available.

What's Happening

AMONG SERVICE AND SUPPLY MEN

Max Bowerman

Edwin P. Illsley

John E. Burkett

Joseph P. Beyer

Travis V. Rankin

Sondol E. Werner

Marvin Gwinn

Gil Lastrapes

George West

Owen H. Walker

Ted Stunkard

Glenn C. Merkley

Max Bowerman has been made general manager of **Hycalog, Inc.** after serving as manager of operations since 1952. He recently completed his tenth year with the company, starting as a logging engineer in 1945. He later served as district manager in the Corpus Christi area and as manager of both West Texas and South Texas districts.

Chiksan Company has announced the appointment of three new salesmen for the Western region. Two of the men, **Edwin P. Illsley** and **John E. Burkett**, will operate out of the Brea home office serving Southern California. **Joseph P. Beyer** will headquarter at the Oakland office which serves northern California. Burkett formerly was sales manager and part owner of Waterwear Company and was on the sales force of Albert Milling Company. Illsley has been Chiksan production control supervisor since 1952, and Beyer, former Pan American Airways radio operator, joined the company after working in sales and service for International Business Machines.

Colton Chemical Company, a division of Air Reduction Company, Inc., announces the appointment of technical service representatives for the East and West Coasts. **Travis V. Rankin,** new technical service representative in the Far West and Rocky Mountain regions, formerly was with Nopco Chemical Company on the West Coast. He will represent all Colton products and will work with Colton distributors and agents throughout his territory from headquarters at Air Reduction division, Emeryville, Calif. Colton representative for the East Coast is **Sondol E. Werner,** with headquarters at the sales offices of Pure Carbonic, division of Air Reduction Company, in Newark, N. J. Werner previously was with United States Industrial Chemical Company and Archer-Daniels-Midland Company on the East Coast.

Marvin Gwinn has been appointed director of advertising for **Security Engineering Division,** one of the Dresser Industries, a newly-created post that is part of Security's expansion program. Gwinn first did field sales work in West Texas after joining Security in 1955. He previously had been advertising manager of Shamrock Oil and Gas Corporation and vice president of a Dallas advertising agency.

Gil Lastrapes and **George West** recently joined the **Oil Center Tool Company** sales organization. Lastrapes, formerly with Orbit Valve Company, will represent OCT in South Louisiana. He will headquarter in Lafayette. West has been assigned to the Williston Basin area where he will make his headquarters in Williston, N. D.

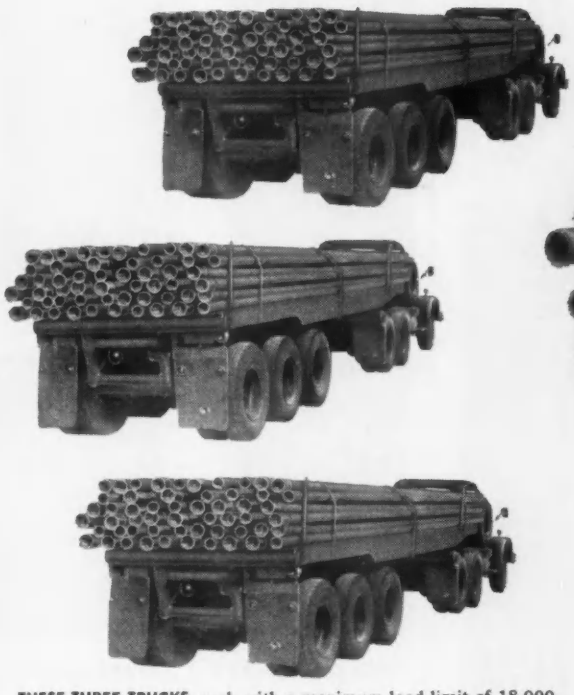
Orbit Valve Company announced the appointment of **Owen H. Walker** as field representative for the Houston and Beaumont area. Formerly with Gulf Oil Corporation as sales supervisor, Walker now will headquarter in Orbit's Houston branch office.

Ted Stunkard has been appointed sales representative in the Kansas area for **Well Equipment Manufacturing Corporation.** He will be located in Grent Bend, Kansas. Before joining Weco, Stunkard spent eight years in oil country sales and service work with American Tank Company, Creekmore Drilling Company in New Mexico and Oklahoma, and United Supply Company.

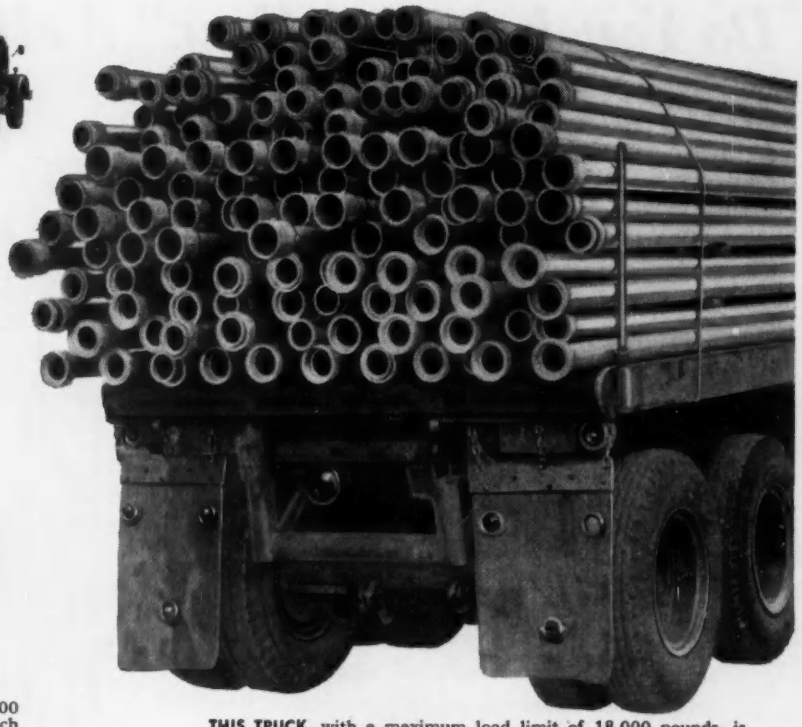
Glenn C. Merkley's appointment as plant manager at the Torrance, Calif., plant is announced by **The National Supply Company.** He will be in charge of the steel, fabricating and plant staff departments under direction of J. D. Spalding, works manager. Merkley was first employed in the inspection department in 1923. During the past 33 years he has been working principally in engineering and sales, occupying such positions as district manager of the California Merchandising division, manager of the San Francisco office and manager of industrial product sales.

Charles L. Piskac, a former territorial manager of **Oil Base, Inc.,** has been promoted to assistant division manager in the Oklahoma, Kansas, Louisiana area with headquarters at Houston. He will report to A. K. Brown, division manager. The promotion is effective immediately. Piskac has been with Oil Base, Inc., since 1947. **Charles DeAinza** has been appointed territorial manager of the San Joaquin area of California.

Bob Colclasure has been named the station manager of the **Welex Jet Services, Inc.** office at Plainville, Kansas. With the company more than three years, he has served as trainee, shooter and sales engineer at Great Bend, Kansas. In the Gulf Coast division. **E. L. (Stub) Blackman** has been appointed sales engineer. A veteran of 16 years of oil well service work, he returns to Welex after a three-year absence. He was with the Gulf Coast division staff of Welex from 1949 to 1953. In Odessa, **Bob Rutherford** has been appointed salesman for the district office. He has been serving as rigman in field service work the almost two years he has been with the oil well service company.



THESE THREE TRUCKS, each with a maximum load limit of 18,000 pounds, are loaded to capacity with 55 lengths of 30-foot, 4-inch steel pipe. Total weight of the steel pipe is over 53,500 pounds—barely within load limits! Total pipe footage—only 4,950 feet, substantially less than a mile!



THIS TRUCK, with a maximum load limit of 18,000 pounds, is loaded with 176 lengths of 30-foot, 4-inch Kaiser Aluminum pipe! Total weight of the pipe is about 5,500 pounds—well within the load limit! Total pipe footage—one full mile!

ONE TRUCK CARRIES A FULL MILE OF LIGHTWEIGHT KAISER ALUMINUM PIPE!

As YOU can see from the pictures on this page, load limit based on weight is *not a factor* with lightweight Kaiser Aluminum petroleum pipe.

At least three trucks are required to haul a mile of commonly used steel pipe. But this same footage can be hauled *easily with only one truck* when you use Kaiser Aluminum pipe!

With Kaiser Aluminum pipe you cut the cost of hauling by two-thirds!

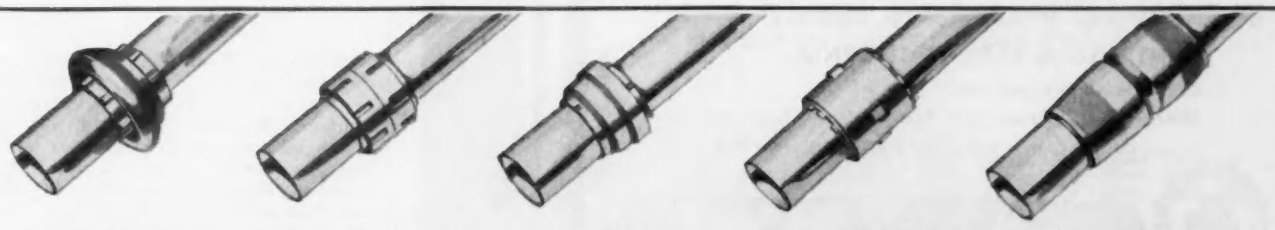
And this is only *part* of the savings you get when you use the Kaiser Aluminum pipe and coupler system for your supply lines. Newly developed detachable couplers speed connecting and disconnecting time to give you additional savings of $135.48 per mile! And the light weight of Kaiser Aluminum pipe permits extremely fast handling, resulting in savings up to $84.35 per mile on loading, stringing and pickup!

Your nearby supplier stocks Kaiser Aluminum petroleum pipe in 30-foot lengths of 2, 3 and 4 inch diameters, with cladded inside surfaces for added corrosion resistance. He also has couplers and fittings to complete your system.

For further information, contact the Kaiser Aluminum sales office listed in your telephone directory or any of the fitting manufacturers listed below. Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office*, Palmolive Bldg., Chicago 11, Ill.; *Executive Office*, Kaiser Bldg., Oakland 12, California.

Kaiser Aluminum

setting the pace—in growth, quality and service



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Food Machinery & Chemical Corp.
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San Jose, California.

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Gateway Engineering Co.
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Industrial Coupler Co.
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Spokane, Wash.

Made by
Warren Manufacturing Co.
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Riverdale, N. J.

Made by
Wright Engineering & Supply Co.
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Denver 23, Colo.

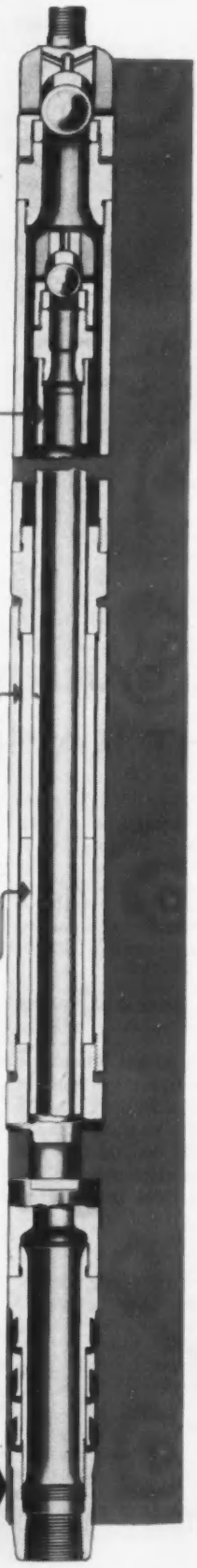
THESE FIVE tested and approved fittings require no welding: field tie-in to existing systems may be accomplished quickly and easily. Couplers assure leakproof connections at liquid and gas pressures of 0 to 1000 psi.

Do You have a "Frac" Well that's tough to Pump?

THEN you should try a Pacific "OIL STATES" rod insert, bottom hole oil well pump...

WHY? because the "OIL STATES" is pumping some of the toughest, sandfrac wells in the Mid-Continent fields—from the extreme depths in West Texas and the gulf coast to the shallower zones in Oklahoma, Kansas and Illinois...

In well after well, oil operators report highly successful pumping with Pacific "Oil States," particularly after trying cup and ring pumps or metal-to-metal pumps with wide tolerances between plungers and tubes. The Pacific "Oil States" offers a new approach to pumping sandy or dirty oil wells. Specifically manufactured to a very close tolerance between plunger and liners, so as to eliminate sand passing between the sealing surfaces which normally cut and score plunger and liners. The Pacific "Oil States" is not merely a "clean-out" pump. It is engineered to pump sand with its "surging action" and further, to pump with a high efficiency made possible only by the close tolerance.



Check these features:

- Furnished with a tolerance between plunger and liners in fits as close as Minus ½ thousandth...
- Furnished in standard steel with stress-proof, heat treated fittings for normal sandy pumping...
- Furnished with stainless steel barrel and parts with "PACILITE" Hard Chrome Plunger for corrosive conditions...
- Furnished in "Stroke-Thru" design to eliminate sticking of plunger and liners in wells that deposit gyp or barium.
- Furnished in pump lengths from 4 feet to 20 feet, with a wide choice of arrangements of valves and fittings...
- Furnished in the following sizes and bores:
  1" and 1¼" for 2" tubing
  1½" and 1¾" for 2½" tubing
  2¼" for 3" tubing
- Plunger and Liners can be "Reground" several times to give the most economical repair costs...

PACIFIC PUMPS INC.

HUNTINGTON PARK, CALIFORNIA

Offices in All Principal cities

Mid-Continent Division: 1221 East 1st Street, Tulsa, Oklahoma

Export Office: Chanin Bldg., 122 E. 42nd St., New York

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DW-15

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Frank J. Richardson

Ralph E. Kauffman

Joe M. Winter was appointed manager of sales and service of the California district for Franks division, **Cabot Shops, Inc.**, effective February 1. Winter, who has been assistant sales manager and service manager of the Compton office and repair shops, has been with the Franks organization since 1950. He served as service manager in California in 1952 and was sent to Edmonton, Alberta, Canada in 1953 to open a Franks division there where he served as sales and service manager.

Lewis A. (Bullet) Gray, recently appointed technical sales representative for **Crossett Chemical Company**, will make his headquarters in Wichita Falls, Texas. For the last several years he has been an engineer for two large mud companies.

Frank J. Richardson, Jr., has rejoined **B and W Inc.** at the Houston headquarters in sales representation. After several years with the firm in sales and service work in Gulf Coast oil fields, Richardson went into construction materials sales.

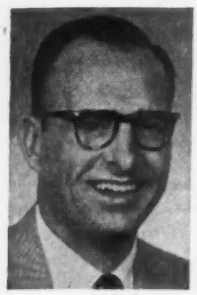
Leota Abrams, formerly secretary of **Abrams Aerial Survey Corporation**, recently became first vice president of the pioneer aerial mapping firm, and **F. Jay Wise**, treasurer, was made secretary and treasurer. **W. S. Karr**, vice president and manager, became executive vice president. **Ralph E. Kauffman**, sales manager, who has been with the firm eight years, was made vice president in charge of sales.

•

McCullough Tool Company, Canadian division, announces the appointment of service engineer **L. M. Oaks** to district manager, Regina district branches in Saskatchewan and Manitoba. Oaks will be in charge of the company's operating stations at Regina, Swift Current, Estevan and Carnduff in Saskatchewan and Virden in Manitoba. He will make his headquarters at the McCullough branch in Regina. Oaks began his career in the oil business in 1927 working in the Mid-Continent area on production and drilling tools. In 1944 he joined McCullough, transferring to the Edmonton, Canada branch in 1950.

Carl H. Simon

Dick F. Sable



Robert F. Kercher

James A. Cusator

Darling Valve & Manufacturing Company recently announced the following personnel changes: **Carl H. Simon,** named vice president and general manager to assume full responsibility for all company operations; **Dick F. Sable,** named general sales manager; **Thomas C. Jester,** appointed chief engineer; and **James N. Elwood,** formerly plant manager and general superintendent, named manager in charge of manufacturing. Sable, formerly southwest regional manager, went to Darling from Magnolia Petroleum Research in 1945. He will retain offices in Dallas. Jester, promoted from assistant chief engineer, joined Darling in 1945. He had been a metallurgical engineer with General Electric. Elwood joined Darling in 1945. **Packer B. Young,** former assistant sales administrator, has been named assistant sales manager.

The Weatherford Oil Tool Company recently named **Robert F. Kercher** district sales and service engineer for northern Oklahoma. He will work from the company's Oklahoma City office. Weatherford moved Kercher from Ft. Morgan, Colo., where he handled sales and service in the northeast part of the state. Before joining the oil field specialties and service company, Kercher was store manager for Franklin Supply Company.

Core Laboratories, Inc., announces the appointment of **James A. Cusator** as manager of the Shreveport district. Until recently, Cusator served as assistant district engineer for Core Lab's ten-state Rocky Mountain region. In his new position, he will direct the company's integrated reservoir engineering services throughout East Texas, north Louisiana and Arkansas.

Schramm, Inc., announces the appointment of **P. F. Smith, IV,** as dealer sales manager. **Joseph E. McGrogan** continues as regional sales manager in charge of Southern and Central territories; **Arno O. Witt** continues as manager of Canadian and export business; **John P. Powell** becomes regional sales manager of Eastern territories; and **Donald M. Thomson** continues as Western sales manager with headquarters in San Francisco.

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Another record in drilling activity is shaping up for this year . . . and the greatest gain in wells drilled will be made by Lone Star Steel's neighbors in Texas, Louisiana, Oklahoma, Kansas and nearby states. The use of Lone Star pipe is setting a new record, too.

Lone Star's casing, tubing and line pipe are manufactured to API standards. The huge Lone Star Steel plant operates for the special convenience of Joe Roughneck, heart of the oil industry. Whether Joe is doing a rugged job on a rig in the field . . . or whether he has become president of his company . . . he's the man who knows oil and pipe. He knows Lone Star is his dependable supplier.

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J. H. Fenton

C. A. Sanders

J. H. Fenton is now manager of the West Central Texas district of **U. S. Steel's** Oil Well Supply division. He was employed by Oilwell in 1938 and served in various California locations in sales and managerial positions until 1942, when he was appointed field auditor at Dallas. In 1951 he was appointed district merchandise manager and, later, assistant district manager at Wichita Falls, Texas, where he remained prior to his present appointment.

Mid-Continent Supply Company recently announced promotion of **C. A. Sanders** to director of credits. Sanders, formerly assistant to the treasurer, will continue to be located at Fort Worth. With Mid-Continent since 1938, he served the company at several locations in Texas, New Mexico, Arkansas and Louisiana before transferring to New York City in 1949. He returned to Fort Worth in 1951 and worked in the Purchasing and Treasury departments before becoming head of credit operations.

Leonard Eller's appointment as assistant superintendent of **Lone Star Steel Company's** electric weld pipe mills has been announced. He served with the Chicago division of Republic Steel as tube mill engineer six years before moving to Lone Star. With Eller's appointment, **Cliff Wright** moves up to head the Utilities department, and **Fred Farmer** takes Wright's place as combustion engineer. Wright and Farmer both joined Lone Star in 1953.

H. C. Pitcher has been named general manager of **Graver Construction Company, Inc.**, subsidiary of Graver Tank & Manufacturing Company, Inc. He will make his headquarters in New York City. Formerly construction manager of the M. W. Kellogg Company, Pitcher has had more than 20 years' experience in the building of industrial plants throughout the U. S.

Leonard K. Buller has been named field supervisor for **Southern Geophysical Company's** Houston office. With Southern for five years as party chief, he will supervise seismic crew operations in the Texas-Louisiana Gulf area.

Wallace W. Wilson, chief of the reserves and evaluation section and formerly chief reservoir engineer of Continental Oil Company at Houston, has joined the **Continental Illinois National Bank and Trust Company** of Chicago as petroleum engineer in the oil and gas department. Before joining Conoco, Wilson worked on secondary recovery problems for the California Research Corporation.

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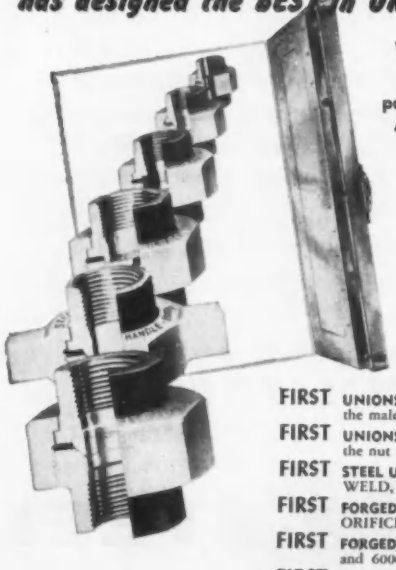

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William H. Hartsell

J. B. Markolf

R. M. Chatham, Jr.

C. F. Grice

Schlumberger Well Surveying Corporation has announced the following transfers of personnel: **William H. Hartsell** has assumed the position of manager of the Golden Meadow, La., location. Prior to this assignment, he had been manager of the Laurel and Brookhaven locations. He has been with Schlumberger since 1942. **J. B. Markolf,** named manager of the Midland, Texas, district office, formerly was manager of the Wichita Falls location and assistant to the division manager of the Permian Basin division in Midland. **J. A. Gilreath** has assumed the position of manager of Schlumberger's Laurel, Miss., location, transferring from Jennings, La., where he also served as location manager. **R. M. Chatham, Jr.,** promoted to manager of the Houston field location, previously served as field engineer in both Houston and Beaumont. **Frank H. Eastman,** promoted from field engineer to division engineer for the Texas Gulf Coast division, will assist the Texas Gulf Coast division manager in matters pertaining to technical quality of Schlumberger service. **M. L. Millican,** formerly manager of the field location at Midland, Texas, has been promoted to assistant to the division manager of the Permian Basin division there. He joined Schlumberger in 1947. **C. F. Grice,** named manager of the company's field location at Monroe, La., joined Schlumberger in 1950. He has served as a field engineer in Magnolia, Ark., and Tyler, Texas.

Austin Jones, a member of the research staff in **The Chemical Process Company's** laboratory in Breckenridge, Texas, has been transferred to the firm's Hobbs district as a field engineer. He joined Chemical Process early last year and spent several months in the field prior to entering the company's lab.

Marshall N. Stickel, sales representative for the **Lunkenheimer Co.,** has retired after 32 years' continuous service with the firm. He joined the Lunkenheimer sales staff in 1923. His original sales assignment which covered the New Orleans territory later was expanded to include the Gulf Coast and Texas.

Charles L. Holbert, recently elected a vice president of **H. K. Porter Company, Inc.,** will be headquartered in the general offices in Pittsburgh. Holbert had been executive vice president, Southern Pacific Milling Company and executive vice president of the Johnston Pump Company prior to joining Porter.

Richard M. McKenna has been appointed district sales representative for **Leschen Wire Rope Division,** H. K. Porter Company, Inc. His territory includes Manhattan, Bronx and all of Long Island. He formerly was with Edward Ehrbahr Equipment Company in New York five years.

Waukesha Motor Company announces three new appointments to executive positions in the company; one of them in the Purchasing department and two in the Railroad division. **C. K. Jones,** who has been employed since 1944 in the Purchasing department, has been promoted to assistant manager of purchases. In the Railway division, **Melvin C. Erickson** has been appointed chief engineer, and **Paul E. Mantz,** assistant sales and service manager. Erickson, who joined the company in 1953, has a background of engineering experience including two years with the Hytol Conveyor Company and 12 years with the Nordberg Manufacturing Company. Mantz has been with the company since 1936; for the past six years he has travelled extensively as field sales and service engineer.

Continental Supply Company announced the following personnel changes: **Leonard Botts,** former production equipment specialist at Wichita Falls, Texas, is being transferred to Continental's Maracaibo, Venezuela, outlet. An employe of the company since 1947, he previously was district machinery representative at the Wichita Falls office. **Morris S. Caraway,** an employe of the oil field supply company seven years, will replace Botts as the production equipment specialist in the district office at Wichita Falls. Caraway formerly was assistant to the manager of the Production Equipment division in Continental's office in Dallas. **Dwight W. Mayes,** with Continental since 1951, is new store manager at Virden, Manitoba, Canada. He is replacing **J. B. Eyndhoven,** who will become manager for the Estevan, Saskatchewan, store. Mayes was field salesman at Sherman, Texas. Eyndhoven's previous positions have been as field salesman.

Speck Suber, former district superintendent for **Otis Pressure Control, Inc.,** in Falfurrias, Texas, has been transferred to the firm's Corpus Christi division as district superintendent. Prior to joining Otis 12 years ago, Suber was in the field for Grady Vaughn, Sinclair Prairie, and other operators. He previously was stationed in the Otis branches in Corpus Christi and New Iberia, La.

Joe H. Smith and **Charles L. Cawthon, Jr.,** have been appointed factory representatives for the **Axelson Division** of U. S. Industries, Inc., in the Mid-Continent district. Cawthon, formerly with Cities Service Oil Company, is assigned to the Wichita Falls, Texas, area, and Smith, to the Odessa, Texas, area.

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Hughes Tool Company Forms North Texas Division

Formation of a new district in Hughes Tool Company's North Texas division, with headquarters in Wichita Falls, Texas, recently was announced. Olen D. Saulsbury, appointed manager of the new district, has been with Hughes since 1943.

Automatic Power, Inc. Organized in Houston

Organization of Automatic Power, Inc., has been announced by its president, N. H. (Available) Jones. The new firm will manufacture packaged power units designed for unattended operation in remote locations where commercial power cannot be obtained.

Major uses of the units will be to provide power for offshore operations, microwave stations, radar networks, air and sea navigational beacons, pipe line stations and remote telemetering. Principal work of the firm at this time is the manufacture of fog signal units to warn vessels of the presence of offshore drilling structures. These signals operate automatically unattended for 21 days sounding a signal that can be heard two miles.

A 3600-square foot corrugated steel manufacturing plant, the first of three in a $150,000 program, has been put into operation. It is completely equipped for the fabrication, testing and assembly of three units a week.

Other officers in the new firm are R. C. Lockwood, vice president, and John Ryan, secretary and treasurer.

New York Bank Opens Branch in Saudi Arabia

The First National City Bank of New York has opened an overseas branch in Jeddah, Saudi Arabia. It is the only branch of an American bank in Arabia and becomes the sixty-sixth of First National City's fully staffed overseas branches, offices and affiliates.

Jeddah is the seat of many government offices and departments and is the main Red Sea port of Saudi Arabia. It is the third branch of First National City in the Middle East, the bank opening branches in Cairo, Egypt, and Beirut, Lebanon, during 1955.

Chester B. Grant, who has served in the bank's overseas division since 1926, is manager of the new branch.

Mason-Neilan to Become Worthington Division

Worthington Corporation and Mason-Neilan Regulator Company have concluded an agreement for the transfer of the net assets of Mason-Neilan to Worthington in exchange for Worthington common stock. Mason-Neilan plant and facilities will be operated as the Mason-Neilan division of Worthington, and the entire working force and management staff will continue in their present positions.

The merger will unite two manufacturers in complementary fields. Mason-Neilan control valves and regulators, in conjunction with Worthington pumps, compressors, turbines and other types of industrial machinery, are used in automatically controlled production systems. The full line of Mason-Neilan products will continue to be manufactured.

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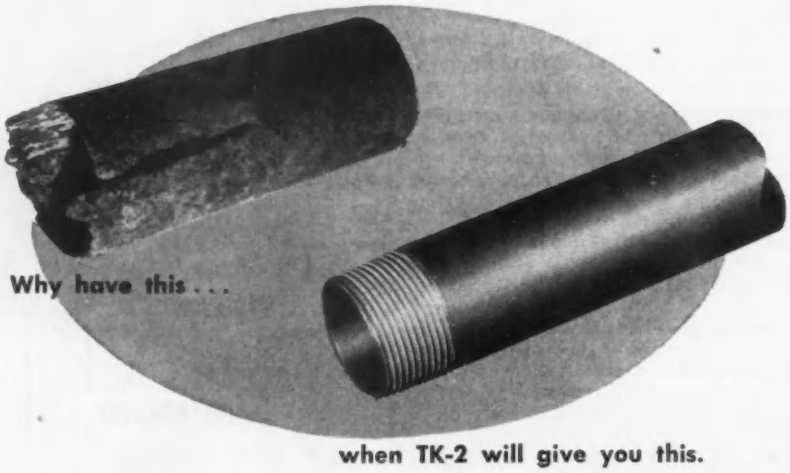
Dependable **protection against corrosion and paraffin deposits...**



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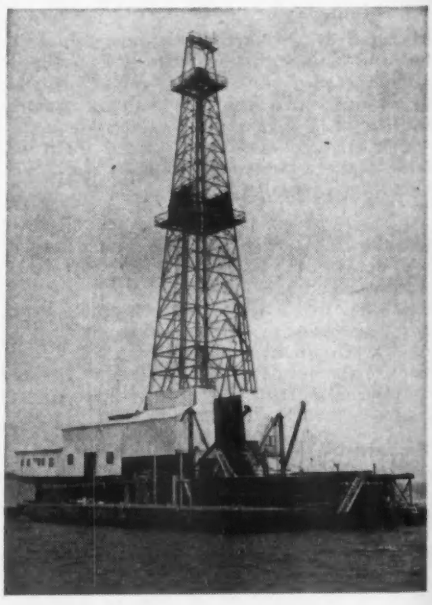

Drilling Barge Completed

Alexander Shipyard, Inc., recently completed an inland marine barge for Gracey-Hellums Corporation which measures 185 feet by 48 feet and is equipped for 20,000-foot drilling. The barge, equipped with two seven-ton booms, has storage capacities for 1100 barrels of diesel fuel, a 480-barrel active mud pit, two sand traps of approximately 100 barrels each, 1250 barrels reserve mud, 5200 barrels of drilling water, and dry mud storage for 3000 sacks. The barge went on its first location at Cailou Bay early this year.

Radiator Speciality Company Names Texas Representative

Phil Douglas, representing Radiator Speciality Company, now is making calls on all Texas oil producing headquarters introducing two products used in oil field, pipe line and other production operations. TITESEAL, available in many different blends, is the gasket and joint sealing compound designed for use in oil field operations, natural gas fields, LPG, refrigeration, railroads, automotive and industrial plants wherever loss or danger due to leaks must be avoided. LIQUID WRENCH, the second product, is a quick-acting rust solvent especially useful along the Gulf Coast where salt water creates rust and corrosion problems.

Phil Douglas

Bovaird Supply Company Holds Annual Sales Meeting

Plans for the future, following a review of a satisfactory and encouraging year in 1955, were highlights of the annual sales meeting of the Bovaird Supply Company recently held in Tulsa, headquarters of the oil field supply company.

Attending the meeting were 60 district managers, store managers, city sales representatives and key personnel of the general offices. The company now has 26 offices and stores in Colorado, Illinois, Kansas, New Mexico, Oklahoma and Texas.

The three days' sessions were conducted by Raymond E. Batchelor, vice president and sales manager; Wm. J. Bovaird, general manager of stores; R. M. McMahan, secretary and purchasing agent; T. H. Trower, treasurer; and Roscoe G. Ayers, vice president and general manager, who also presided. D. D. Bovaird, president of the company, reviewed company policies and accomplishments.

Lane-Wells Reorganizes Divisional Organizations

To streamline control over expanding activities, the Lane-Wells Company has reorganized its divisional organizations. Division managers report directly to J. M. Henderson, manager domestic operations. Gulf Coast and Mid-Continent divisions are now divided into two regions, each with its own regional manager reporting directly to the division's manager of field services.

In the Gulf Coast division, E. A. Radack becomes manager of field services. J. P. Myers has been named regional manager for the Northern region, which includes the Arklatex district, R. G. Grant, district manager; the North Central Texas district; W. A. Johnson, district manager; and the West Texas district, J. W. Kiser, district manager.

Regional manager for the Southern region is O. J. Guseman. The Southern region comprises the Houston district, C. E. Shilcutt, district manager; the Southern Louisiana district, A. L. Boyd, district manager; and the Southwest Texas district, R. A. Whittlesey, district manager.

Ray A. Hancock has been appointed manager of field services in the Lane-Wells Mid-Continent division. This division has been divided in an Eastern region, with J. E. Compton as regional manager, and a Western division headed by Regional Manager M. D. O'Haver.

Three districts comprise the Eastern region—the Illinois district, C. O. Ohl, district manager; the Oklahoma district, J. F. Alexander, district manager, and the Kansas district, with Ed Sayeas, district manager.

The Western region of the division also consists of three districts—the Farmington, N. M., district, J. D. Dunigan, district manager; the Rocky Mountain district, L. C. Thaxton, district manager; and the Williston district, headed by District Manager G. W. Long.

Parnell Announces Plans To Open Core Analysis Firm

Ralph W. Parnell is organizing Parnell Core Laboratories, Inc., a firm which will be devoted to core analysis, diamond coring, mud logging and other reservoir engineering services for the petroleum industry in the Ark-La-Tex area. Parnell recently resigned as district engineer and member of the board of directors of Core Laboratories, Inc.

Home offices and laboratories of the new firm will be located in the Ricou-Brewster building, Shreveport. Branch offices will be opened in El Dorado, Ark.; Tyler, Texas, and New Orleans.

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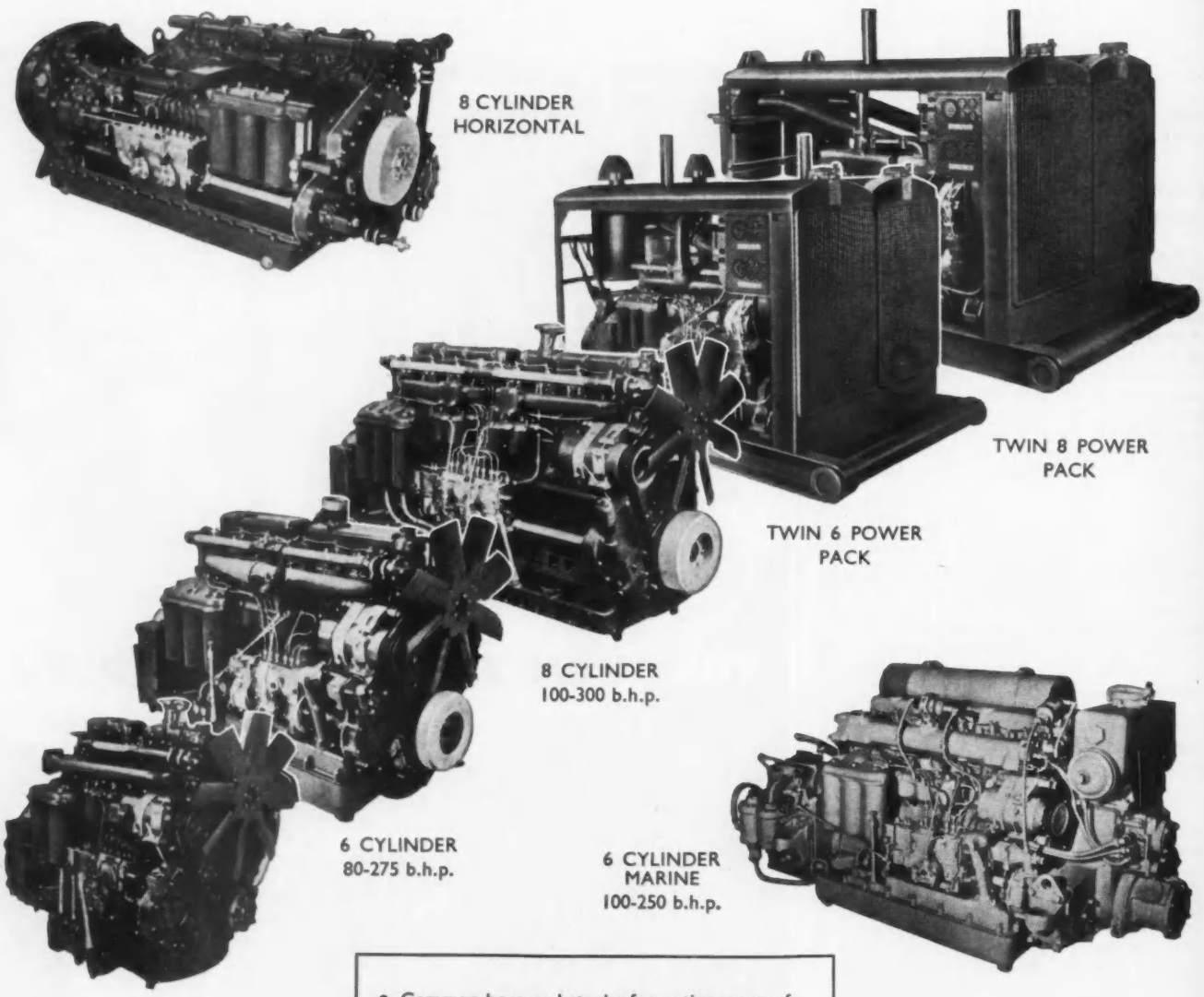

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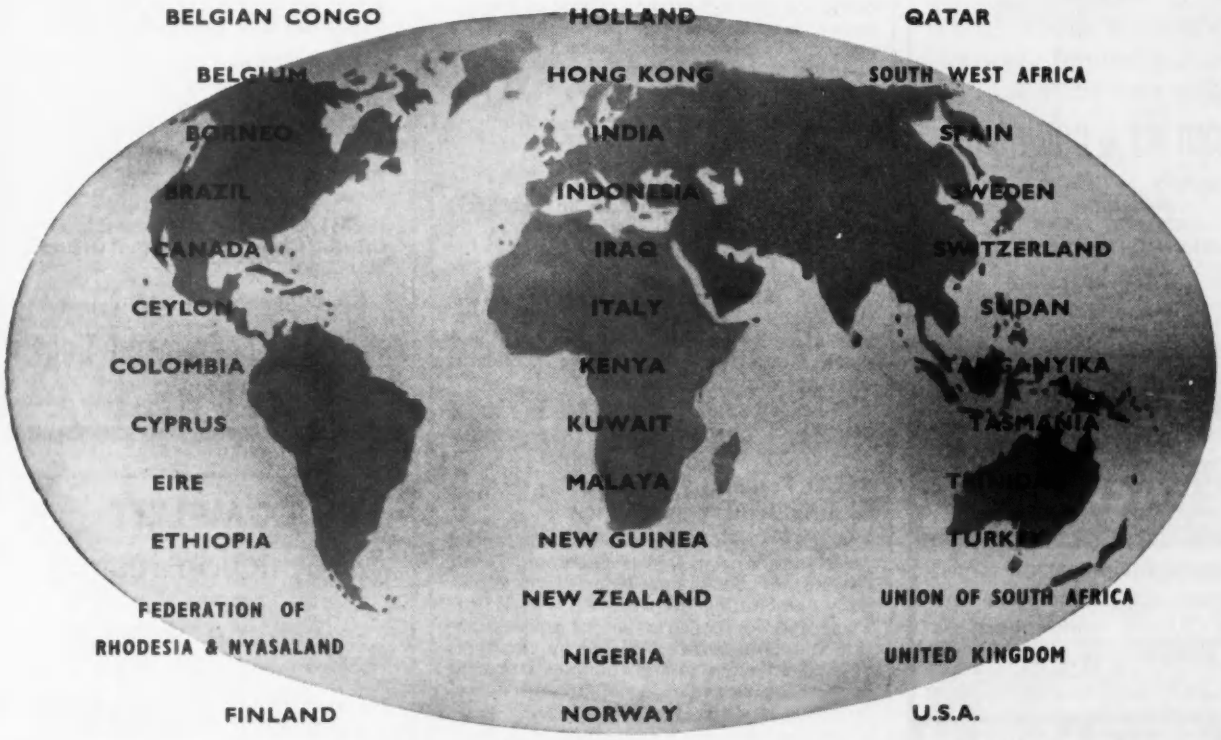

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Advertising Man Honored

L. D. (Red) Webster (left), vice president of Lone Star Steel Company, was co-master of ceremonies at a testimonial luncheon given recently for Don L. Baxter, president of Don L. Baxter, Inc., oil and gas industry advertising agency. The occasion was Baxter's silver anniversary as an advertising executive and the tenth anniversary of the founding of his firm.

Sharp Is Board Chairman Of Mission Manufacturing

At a meeting in Houston in February, stockholders of Mission Manufacturing Company elected officers and directors for the coming year.

W. B. Sharp was elected chairman of the board and president. Richard E. White was named executive vice president, and Anan Golub was elected vice president, secretary and treasurer.

Other directors included W. T. Campbell, D. C. Sharp, Jr., and Ross Bennett.

ALCO Products Announces $1.5 Million Expansion Plan

ALCO Products, Inc., has announced an expansion plan for its Beaumont plant, the former Beaumont Iron Works Company, amounting to over $1.5 million. Plans call for construction of a combination warehouse-office building on two acres of land adjacent to the company's present property, plus expansion of present manufacturing facilities.

The warehouse, to be completed in June, will include 14,000 square feet of storage space plus 6000 square feet of office space. The offices, to be built at the front of the warehouse, will be of brick and glass construction and will house the manager's office, marketing and engineering departments.

Expansion of the present Beaumont plant will include increased facilities for production of heavy-duty heat transfer equipment, as well as oil drilling and production equipment.

New Odessa Supply Firm To be Monarch Distributor

Announcement has been made of the organization of a new firm, Monarch Pump & Supply, Inc., Odessa, Texas, for exclusive distribution in the West Texas area of Monarch pumps, parts and related equipment.

Affiliated with Monarch Engineering Corporation of Los Angeles, the new firm is headed by R. E. (Skeet) Berry and George W. Willson, both veterans of Mid-Continent oil field work.

Texas Instruments to Buy Burlington Instrument Line

Announcement of an agreement to purchase business and assets of the Burlington Instrument Company has been made by Texas Instruments Incorporated. The acquisition will both complement and broaden the range of electronic and electromechanical components and systems available from the Texas firm.

Entire operations of the Burlington Instrument Company, Burlington, Iowa, will be integrated with the TI Components division and transferred to Dallas.

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Veteran Employe Given Groundbreaking Honors

Groundbreaking for Well Equipment Manufacturing Corporation's new 76,000 square foot office and plant in the Lumpkin Industrial district in Houston, is performed by Vic Norton, Weco's oldest employe in length of service. Watching, left to right, are: C. H. Callahan; J. C. McCelvey; Dan Permesan; Art Schmitz, of Food Machinery and Chemical Corporation; John Gates; Russell Ford; J. H. Robinson; S. Knutson, general contractor; and Travis Broesche, architect.

Du Pont Chemicals Division Has Additives Sales Group

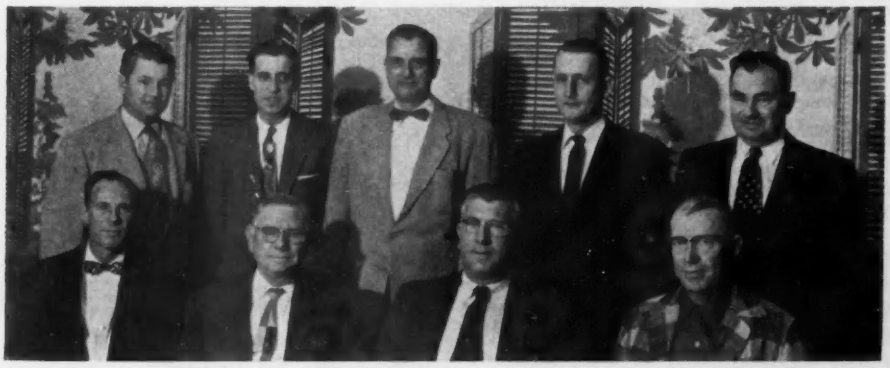
E. I. du Pont de Nemours & Company's Petroleum Chemicals division has established a new additives sales group to improve customer service and to prepare for new petroleum additives developments. J. J. Mikita, formerly director of Du Pont's Petroleum Laboratory, has been named sales manager of the new additives group with headquarters in Wilmington, Del. His assistant will be W. W. Wingate, formerly in the product development group of the Petroleum Chemicals division.

W. E. Bettoney, formerly an assistant director of the Petroleum Laboratory, will become manager for additives in the Eastern region with headquarters in New York. N. D. Lawson, head of the fuels and lubricants section of the laboratory, will take over as manager for additives in the Central region, working out of Chicago. J. B. Malin has been named to the new position in the Western region where he has been regional laboratory manager.

Dr. B. M. Sturgis, formerly assistant director, has been promoted to director of the Petroleum Laboratory. Assistant laboratory directors will be R. O. Bender, in charge of technical service, and R. H. Blaker, handling product evaluation.

King Oil Tool Establishes New Distributing Center

A new distributing center for King Oil Tools has been established in Shreveport, La., at the Tommy Davis Warehouse Company, 1106 North Market St. Davis has been in the oil industry 11 years, starting with Arkansas Fuel Oil Corporation in 1945. Following this, he was with a major oil field supply company five years and was under contract with a major rubber company three years dealing directly with oil field supply and the oil and gas industries.



Hawthorne Sales Executives Meet

Among Herb J. Hawthorne, Inc., sales executives who met in Houston recently to discuss exploration sales market potentials in 1956 and outline the company's sales planning were, left to right, seated: W. T. Brown, West Texas-New Mexico field service engineer; J. L. Patterson, Gulf Coast field service engineer; C. T. Baker, Mid-Continent field service engineer; and C. Max Fountain, Rocky Mountain field service engineer. Standing, left to right: John E. McGary, Brennan Advertising Agency, Inc., consultant; Cary Gunn, Canadian field service engineer with Seismic Service Supply Limited, Calgary, Hawthorne Canadian distributors; Earl M. Weaver, general sales manager; Jack W. Thigpen, Central-South Texas field service engineer; and E. L. Williams, Central-East Texas field service engineer.

The new 12-acre plant of W-K-M Manufacturing Company, Inc., at Missouri City, Texas, is designed to permit three distinct product production facilities to function under one roof, the manufacturing plant alone covering almost 11 acres at ground level. Offices occupy 1200 square feet on the second floor of the steel frame building; offices, engineering space, reception and conference rooms occupy the remaining 48,000 square feet of floor space of the lower floor. The plant has a 2250-ton air conditioning system which converts to winter time heating.

W-K-M Opens New Plant, Announces Consolidation

A new W-K-M Manufacturing Company will come into being May 17, along with the opening of its new 12-acre plant on a 75-acre site at Missouri City, a few miles southwest of Houston.

J. S. Downs

It will be a consolidation of W-K-M Manufacturing Company, Houston, a subsidiary of ACF Industries, Inc., manufacturer of gate valves for oil production and pipe line installation; The Key Company, East St. Louis, manufacturer of return bends and fittings for oil refining and chemical processing; and the ACF Valve Division, Detroit, producer of lubricated plug valves for all industrial pipe line uses.

All activities of the three concerns will be conducted in the new plant on Highway 90-A and the main line of the Southern Pacific system. This plant has been designed so that each will function as a distinct manufacturing opration with individual production lines for each product.

Machinery from the former W-K-M plant in Houston, from the Key plant in East St. Louis and the ACF Detroit plant is being set up along with new equipment necessary for the expansion involved in the consolidated operation.

J. S. Downs, president of W-K-M Manufacturing Company, will continue to head the expanded organization. Management and other key personnel from both East St. Louis and from Detroit are being transferred to Houston so all standards of operation can be maintained.

The new organization is to be known as W-K-M Manufacturing Company, Inc., a subsidiary of ACF Industries, Inc.

Petroleum Equipment Suppliers Announce 1957 Officers, Plans

The Petroleum Equipment Suppliers' Association will hold its 1957 meeting at Palm Springs, Calif., April 6 to 11.

This plan was announced April 18 at PESA's 21st annual meeting in Boca Raton, Fla.

Officers of PESA for 1956-1957 were elected at the meeting. Rainey Elliott, of Jones & Laughlin Steel Corporation, Supply Division, Tulsa, was elected president. Grover Kilgore, Halliburton Oil Well Cementing Company, Duncan, Okla., was chosen vice president. Wharton Weems, of Vinson, Elkins, Weems & Searls, attorneys, Houston, was named treasurer. H. R. Safford, Jr., Houston, was reelected executive secretary.

Directors of PESA for 1956-1957 were announced at the Florida meeting.

For the Eastern district, Fred J. Spang, Spang & Company, Butler, Penn., was chosen director emeritus. Mason B. Jones, The S. M. Jones Company, Toledo, will be director at large.

Other directors are as follows: Karl Elliott, Acme Fishing Tool Company; Rainey Elliott, Jones & Laughlin Steel Corporation; Jene Harper, Franklin Supply Company; Lloyd Lamphere, Ajax Iron Works; Donald W. Mackie, Jr., Bradford Supply Company; Frederick F. Murray, Oil Well Supply Division, U. S. Steel Corporation; and A. W. McKinney, National Supply Company.

Also, J. B. O'Connor, Ideco Division of Dresser Equipment Company; Paul Scherf, Alten Foundry & Machine Works, Inc.; John G. Seiler, Tube Turns, Division of National Cylinder Gas Company; H. Bernard Wehrle, McJunkin Corporation; and W. A. Wood, Parkersburg Rig & Reel Company.

For the Mid-Continent & Rocky Mountain district, Guy A. Tompson, Bethlehem Supply Company, Tulsa, was named director at large. Other directors for 1956-1957 will include: R. A. Baker, Franks Manufacturing Corporation; F. E. Bernsen, Lucey Products Corporation; E. C. Bolger, W. C. Norris, Manufacturer; Davis D. Bovaird, Bovaird Supply Company; Paul Courtney, George E. Failing Company; and Grover Kilgore, Halliburton Oil Well Cementing Company.

Also, W. H. Larkin, Larkin Packer Company; M. G. McCool, American Iron & Machine Works Company; Walter O'Bannon, Jr., Walter O'Bannon Company; John G. Staudt, Dowell Incorporated; S. P. Wallace, Maloney-Crawford Tank & Manufacturing Company; and J. E. Webb, Republic Supply Company.

For the Southwestern district, directors at large will include Fred M. Mayer, Continental Supply Company, Dallas; M. E. Montrose, Hughes Tool Company, Houston; and Wallace D. Wilson, Wilson Supply Company, Houston.

Other directors are as follows: H. H. Allen, Cameron Iron Works; Richard E. White, Mission Manufacturing Company; Ken W. Davis, Mid-Continent Supply Company; R. G. Hamaker, Reed Roller Bit Company; Ott Hammer, Security Engineering Division, Dresser Operations; and Frank L. Hereford, Murray-Brooks, Inc.

Also, S. J. Iverson, Iverson Supply Company; Elliott Johnson, Schlumberger Well Surveying Corporation; L. A. Little, Lufkin Foundry & Machine Company; George O'Leary, Houston Oil Field Material Company; H. C. Otis, Otis Pressure Control, Inc.; and Ray O. Shaffer, Welex Jet Services.

For the Pacific district, D. S. Faulkner, National Supply Company of California, Torrance, was named director emeritus. Directors at large are: J. A. Crawford, Youngstown Steel Products Company; E. S. Dulin, Byron Jackson Company; and T. Sutter, Baker Oil Tools, Inc. All are of Los Angeles.

Other directors include: J. L. Evans, National Supply Company of California; W. W. Greenway, Axelson Manufacturing Company; Don Grubbs, Oil Well Supply Division, U. S. Steel Corporation; H. J. Hagn, Chiksan Company; T. J. Hickey, Hickey Pipe & Supply Company; Harold E. Howard, Howard Supply Company; and Wendell Jones, Bethlehem Supply Company.

Also, John J. Neale, Lane-Wells Company; H. H. Peters, Technical Oil Tool Corporation; John J. Pike, Republic Supply Company of California; W. T. Powell, Emsco Manufacturing Company; and W. A. Wilson, Web Wilson Oil Tools, Inc.

Rockwell Expands Branch Office To District Sales Headquarters

The Philadelphia branch office of Rockwell Manufacturing Company's Meter and Valve division has been expanded into a district sales headquarters office; D. H. Shoemaker, branch manager, has been promoted to district sales manager.

Shoemaker joined Rockwell in 1942 as employment manager at the Pittsburgh plant and transferred to sales work in 1946.

Louis McCabe Heads New Engineering Firm

Dr. Louis C. McCabe, former scientist director of the U. S. Public Health Service, now heads the newly-formed engineering firm, Resources Research, Inc. Frederick S. Mallette, executive secretary of the Committee on Air Pollution Controls and research manager of the American Society of Mechanical Engineers, and William S. McCabe, consulting geologist, also are in the new firm. John R. Reeves, former Secretary of State of Maryland, is secretary and general counsel.

Main offices of Resources Research, Inc. are in Washington, D. C., with branches in New York City and Casper, Wyo.

International Aerial Mapping Operates from New Location

Hal Peterson of San Antonio and Kerrville, Texas, has purchased World-Wide Cartography and International Mapping Corporation of San Antonio, and has combined the two into one company to operate as International Aerial Mapping Company.

Both companies and their mapping equipment have been moved into a new building near International Airport especially designed for photogrammetry. William V. Bud Porter of San Antonio has been appointed representative to the oil, gas, pipe line and power industry.

J. J. Houghton

Paul E. Madeley

Electronic Instrument Firm Begins Operation in Houston

Electrodynamic Instrument Corporation has been organized in Houston to develop and manufacture electronic and electromechanical instruments for the oil industry and to offer design and engineering and manufacturing facilities to groups with special problems. Initial product activities will be directed toward data recording and data processing by means of magnetic tape.

Joseph J. Houghton, until recently in charge of mechanical design in the Research and Development department at Southwest Industrial Electronics Company, is president of the new firm. Paul E. Madeley, executive vice president, formerly was a project engineer with SIE. W. F. Stone is secretary-treasurer.

American Chemical Paint To Open Central Office

American Chemical Paint Company has acquired office and plant facilities at St. Joseph, Mo., and expects to be operating there about June.

The new centrally-located office and plant will serve a territory lying between the Mississippi river and the Rockies and from Canada to the Gulf of Mexico. Present plans include production of metalworking chemicals and agricultural chemicals.

Heading the branch will be J. H. Abrams who has been with the company many years in a supervisory capacity in the Pittsburgh territory. In addition, technical representatives will provide service and consultation for ACP customers in the new central U. S. territory.

Survey Expanded Facilities

Looking over the new California headquarters of Bethlehem Supply Company are, left to right, J. R. B. Freeman, general manager of sales; Wendell Jones, vice-president and general manager; and H. W. Robinson, general manager of stores. In addition to the general office, Bethlehem will have at the new Los Angeles address extensive warehouses and pipe yard and machinery alterations, repair and assembly facilities.

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RATES: Regular Classified (undisplayed) set in this size type: 12 cents per word. Minimum charge, $3. Blind box address in our care counts six words. Replies forwarded without charge. **Situation wanted ads,** 6 cents per word. **Display ads,** set in suitably larger type with ruled border, $12 per column inch; situation wanted display ads, $6 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. **All classified ads payable in advance. COPY DEADLINE:** 17th of month preceding date of issue. Send copy and checks to: **Trading Post Section, World Oil, P. O. Box 2608, Houston, Texas.**

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Preferably with some oil field experience in the Southwest who may be interested in reservoir study, pressure maintenance, water flooding, gas repressuring, field supervision, core analysis, and appraisal work in conjunction with our small well established consulting petroleum engineering firm in North Texas. Adequate compensation with advancement. Include personal data, snap shot, oil field experience, scholastic standing, when available, martial status, draft or service prospect, etc. in your letter to Box 97-W, c/o WORLD OIL, Houston, Texas.

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■ DYNAMIC drilling manager, formerly technico-commercial representative of an import American firm wants to have a Europe-Africa representation for Oil Field Rigs, diverse core drills, oil-well tools and control apparatus. Box 96-W, WORLD OIL, Houston, Texas.

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Thirty-five; fifteen years' experience in various phases of oil production in U. S., Canada, South America. Currently senior geologist with major company in South America. Seeking connection with organization having active development program. Prefer foreign, but will consider domestic assignment. Geologist or Petroleum Engineer. Box 84-W, WORLD OIL, Houston, Texas.

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Chemical Laboratory Building

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Gulf Research & Development Corporation
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SQUEAKS from the BULLWHEEL

Six Please

A married man on a business trip relaxed by enjoying a lively weekend with a blonde. After returning home he was visited by a shifty looking man who said, with the innuendo of a professional blackmailer, "Remember that trip you took and that blonde? It happens that I have photographs of everything you did."

The business man gulped, "Everything?"

The blackmailer spread a half dozen detailed snapshots on the desk and said, "Here they are. What are you gonna do about it?

"Well," drawled the business man cooly. "I'll take one of those, and five of this one. Can I have them tinted?"

Why Bother?

Just after Jake was admitted to the hospital, he heard a knock on the door of his room. He called out for whoever it was to come in, and in came a snappy little woman. "I'm your doctor," she said. "Take your clothes off, please,"

Jake asked her if she meant all of them and she told him that's just what she did mean. So he took off all his clothes and she examined him: nose, throat, chest, stomach, thighs, feet. When she got through she announced, "You may get into bed. Do you have any questions?"

"Just one," said Jake. "Why did you knock?"

Good Reason

A drunken man staggered up to a hotel desk late one night and demanded another room.

"But you have the best room in the house, sir," answered the clerk.

"I don't care," was the stubborn answer, "I want another room, and I want it quick."

Realizing that it would do no good to argue or reason with him any further, the clerk turned to the bellboy and said: "Move this gentleman out of 505 and put him in 508, right away."

Completely satisfied, the inebriated guest moved toward the elevator, offering no word of explanation or thanks.

"Just a minute," said the clerk.

"Would you mind telling me, sir, why you don't like room 505?", not expecting a sensible answer. However, he got one.

"The damn thing's on fire."

Born Too Late

Mother was telling her small son about the good times she had when she was a little girl—riding a pony, sliding down a haystack, and wading in a brook at the farm.

"Mother," he said at last with a sigh, "I wish I'd met you earlier!"

Movie Star

The two drunks decided to while away the time playing a guessing game called "Movie Star." The first drunk began:

"I'm five feet four, with long blonde hair, seductive green eyes, a 38-inch bust, 24-inch waist, and 36-inch hips. I'm sultry and languorous, with moist, pouting lips and peaches and cream complexion. Who am I?"

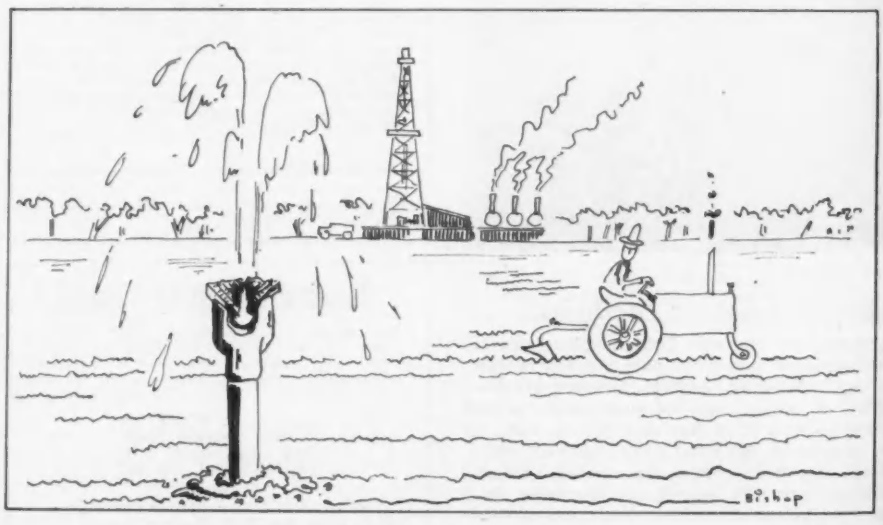
"Never mind who you are," screamed the second drunk. "Kiss me!"

Take Your Choice

Rastus and Liza were married but a short time when he came home with a big washtub, a washboard and a handsome three-foot mirror.

"What's all that junk you got there?" Liza asked.

"You kin take your pick. You kin take the tub and washboard and go to work, or you kin take the mirror and set down and watch yourself starve," Rastus explained.



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McCullough M-3 Bullet Perforators firing improved Ogival Bullets are being used regularly to gain effective penetration in one of the deepest producing fields in Canada.

These wells range in depth from 8900′ to 9100′. 5½″ O.D. 15.5 lb. or 17 lb. casing is cemented in 9″ hole. Producing formation is the tough Mississippian Limestone with variable porosity, much of it below 10%, and with low permeability.

3½″ O.D. M-3 Guns are used, firing a uniform pattern of four holes per foot, and resulting in fine producers.

McCullough M-3 Bullet Perforators are called upon again and again to do the toughest jobs. Solid steel gun bodies that give great strength and permit the use of the most powerful perforating powder loads, simultaneous firing that provides a uniform hole pattern and utilizes the full power of the gun on every shot, and improved Ogival Bullets are a few of the reasons why you get deepest penetration.

For best results, call for McCullough M-3 Guns, "hardest shooting bullet perforators in the world."

Solid Steel M-3 Guns Chalk-up Amazing Record Breaker

Powerful McCullough M-3 Guns Fire 9738 Improved Ogival Bullets in One Well—One Job—Rig Time, 117 Hours

McCullough gun perforating crews, using hard shooting, deep penetrating M-3 Bullet Guns, have again broken their record for shooting the most holes in one well on a single job—and turning in a fine producer, to boot!

9738 improved ½″ Ogival Burrless Bullets were fired in several pay zones. Total depth was 9510 feet and 7″ O.D. 26 lb. and 29 lb. N-80 casing had been cemented through the productive intervals. Guns used were the 4¼″ O.D. M-3 Bullet Perforators . . . the world's best!

The well started flowing after perforating began and made 1700 barrels of oil during the job. A blowout preventer had to be used to keep the well under control, indicating the extent of the problems overcome to accomplish this all-time record.

Records like this can only be established by M-3 Bullet Guns; the original solid steel bodied bullet guns that fire all shots at one time and gain deeper penetration than any other bullet gun. These guns save valuable rig time on any perforating job. On jobs over 100 holes the saving is substantial. On this record breaker the operator realized a tremendous saving; McCullough crews fired an average of 83 burrless bullets per hour.

All 9738 bullets shot in this well were improved ogival McCullough Burrless Bullets. The entire perforated zone was scraped on a single run. The scraper came out without a scratch—no damage from burrs or bullets; and the zone washed perfectly!

This entire operation was as smooth as silk—a fine tribute to the skill and efficiency of McCullough gun crews and to the excellent completion program established by the oil company's engineers.

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A powerful blend of quick-acting solvents that frees "frozen" parts without breakage. Safe for all metals and alloys.

Makes joints **LEAKPROOF!**

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Get them at Industrial or Oil Field Supply Houses.

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"I've never had to buy a derrick since 'Texas Slim' came to work for me."

Not Crazy

First Lunatic: "Betcha you can't climb up that beam of light that's shining in the window."

Second Lunatic: "Do you think I'm crazy? I'd get half way up and you'd turn it off."

Specialty Painter

"So your brother is a painter?"
"Yup."
"Paints houses?"
"Nope, paints men and women."
"Oh, I see, he's an artist."
"Nope, just paints men on one door and women on another."

Sure Way

Client: "How can I get this message to every married woman?"

Publicity Man: "Simple. Address letters to every married man and mark them all 'personal'."

Some Similarity

"Have you seen Ruth's new evening gown?"
"No, what does it look like?"
"Well, in most places it looks quite a lot like Ruth."

Reason Enough

Mary: "Sometimes my Dad takes things apart just to see why they won't go."
George: "So what?"
Mary: "So you'd better go."

Neighbors,

"Where in hell have I seen you before?"
"What part of hell are you from?"

The Big Surprise

Uncle: "You boys of today think too much about money. Do you know what I was getting when I married your aunt?"
Nephew: "No. And I bet you didn't either."

Beatitude

Blessed are the deaf because they cannot hear the dumb.

Definitions

The difference between a New York millionaire and a Texas millionaire is the New Yorker counts his dollars while the Texan weighs his.

Time Is Important

Jane: "Mary, who was that man I saw you kissing last night?"
Mary: "What time was it?"

Ignorance Is Bliss

The Archbishop had preached a fine sermon on married life and its beauties. Two old Irishmen were heard coming out of church commenting on the address.

"Tis a fine sermon his Riverence would be after giving us," said one.

"It is indade," was the quick reply, "and I wish I knew as little about the matter as he does."

How Else?

Drunk: "Ho! Lady, you got two ver' beautiful legs."

Girl (snapping): "How would you know?"

Drunk (brightly): "I counted 'em."

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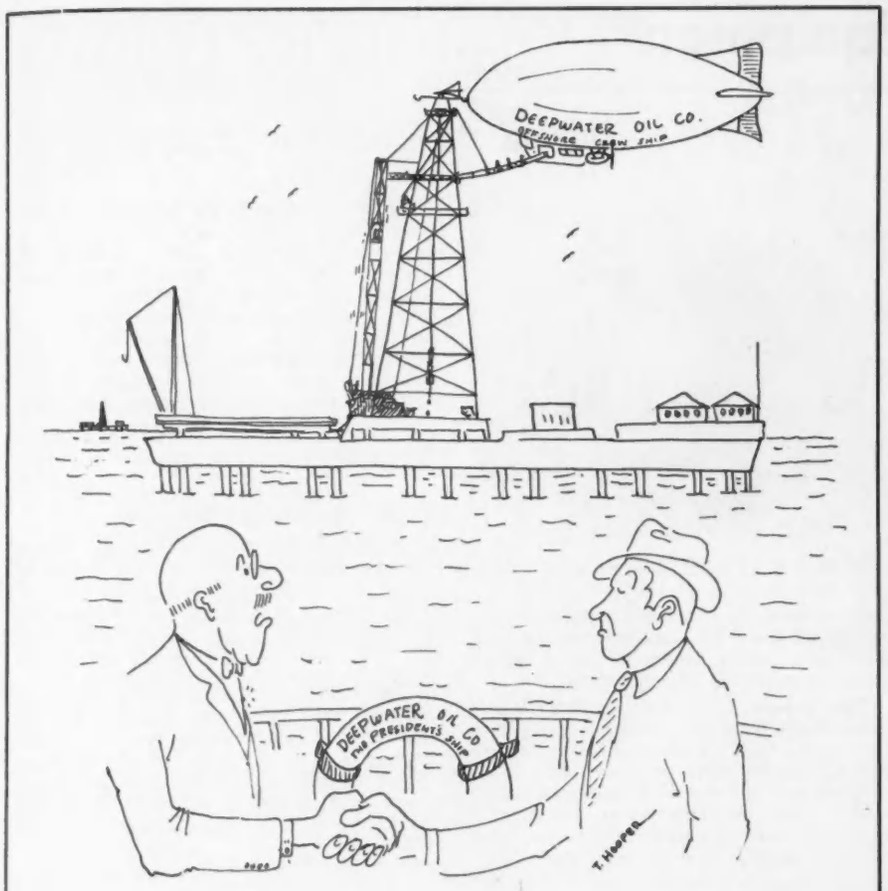
"You'll notice the prominent lines, the three-dimensional effect—the desirable features of any structure."



"Congratulations, Smith. A novel idea."

Sad Fate

Two old friends met for the first time in several years.

"Hear about poor old Ed? He dropped dead outside of Murphy's bar."

"Going in or coming out?"

"Going in."

"What a terrible tragedy."

Had Help

Teacher: "Why was Solomon the wisest man in the world?"

Pupil: "Because he had so many wives to advise him."

How Cordial?

Recipe: The way to make a peach cordial—Buy her a drink.

Words in Her Mouth

Girl: "I'll never go out with a ventriloquist again!"

Mother: "Why not, dear?"

Girl: "Last night he sat me on his knee and you should hear the things he made me say!"

Must Be Drunk

"Are you positive the defendant was drunk," growled the judge, "and why are you so certain?"

"Well, replied the officer, "I saw him put a penny in the patrol box, look up at the clock on the city hall and shout, 'Gad, I've lost 14 pounds.' "

Some Indication

"What makes you think your wife is getting tired of you?"

"Every day this week she's wrapped my lunch in a road map."

Near Miss

A big Indian had just ordered a ham sandwich at a drug counter and was peering between the slices of bread when he turned to the waiter. "Ugh, you slice 'em ham?"

The waiter replied, "Yes, I did."

"Ugh," grunted the Indian. "You damn near miss 'em."

That Long?

Eight years working for the firm—never late—never absent—then one morning he came in an hour and a half late, his clothes torn, his face and hands scratched and bloody.

Asked the boss, "Why are you late?"

"I leaned out the window and fell three stories!"

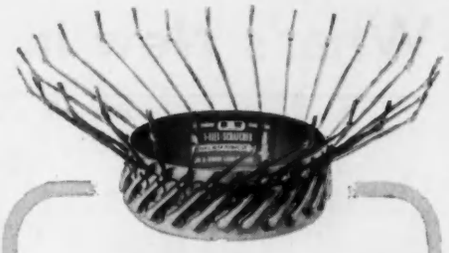
"That took you an hour and a half?"

Sure Thing

A man appeared in a newspaper office to place an ad offering $100 for the return of his wife's pet cat.

"That's an awful high price to offer for a cat," the clerk suggested.

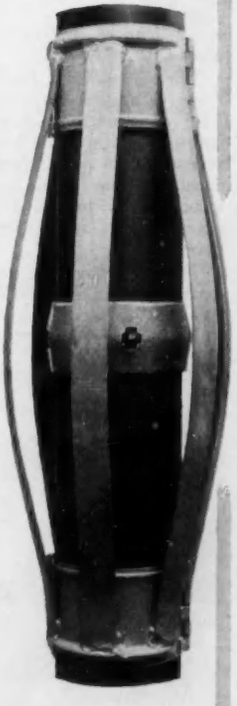
"Not this one," said the man. "I drowned it!"



for a good cement job...

B and W

SCRATCHERS and CENTRALIZERS



Removal of mud cake and prevention of channeling are required for good primary cementing.

B and W introduced the first scratchers to the oil industry in 1939 . . . and in 1946, the first latch-on centralizer, with the Kon-Kave bow for extra centering strength.

These tools, part of B and W's complete line of primary cementing tools, help assure proper hole conditioning for a good cement job.

- B and W Multi-Flex Scratcher
- B and W Hinged Nu-Coil Scratcher
- B and W Rotating Scratcher, Multi-Flex type
- B and W Rotating Scratcher, Nu-Coil type
- B and W Latch-On Centralizer with Kon-Kave Bow
- B and W Latch-On Stabilizer
- B and W Stabilock

B and W Inc.

Well Completion Specialists

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Houston 12, Texas
Phone WA 3-6603

WEST COAST
Box 3751, Terminal Annex
Los Angeles 54, Calif.
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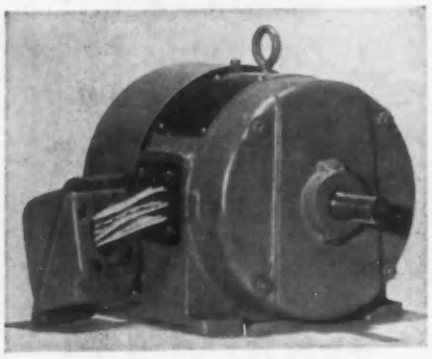
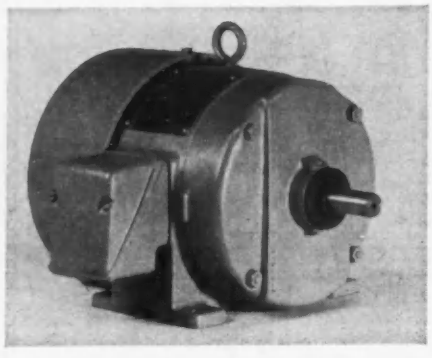
6090

What's New In Equipment

Drilling • Production • Exploration





Two AC Motor Lines

Two new lines of enclosed, non-ventilated, fan-cooled motors have been announced by General Electric's Small Integral Motor department. Designated as Standard Enclosed and Severe Duty Enclosed, the new AC lines will replace a single line of one through five-horsepower motors.

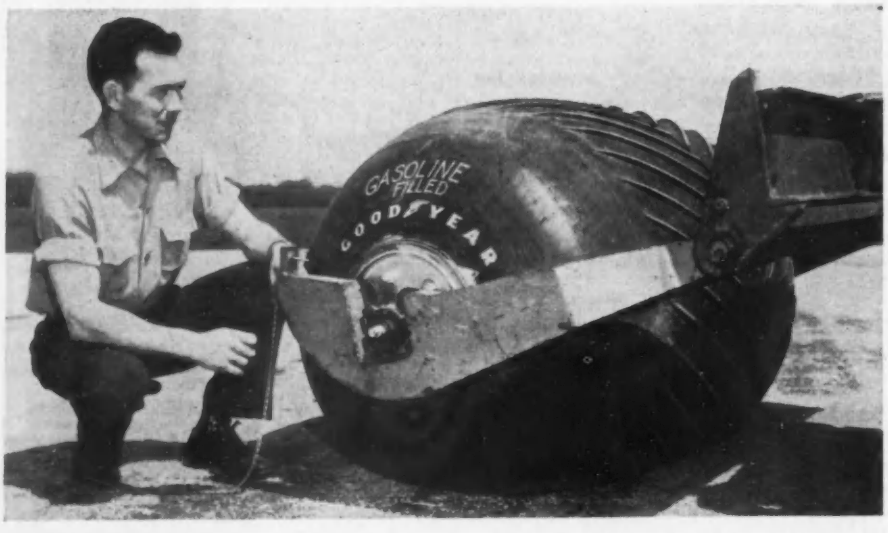
The Standard Enclosed motor (left) features a steel conduit box and fan cover. The conduit box has keyhole mounting for quick and easy installation. Mounting screws need not be removed. A half-inch conduit hole with a three-quarter inch knockout is provided for versatility. The conduit box is gasketed with cork neoprene.

The fan cover, also of steel, is lighter, more rugged and easier to realign on reassembly. Cast iron, for rigidity, is retained on the rest of the enclosure.

Both new lines feature longer permanumbered leads for use with time-saving wire nuts. Every enclosed, foot-mounted motor is equipped with a lifting eye.

The Severe Duty line (right) is the same basically as the standard line except for certain features which make is suitable for use in corrosive or excessively moist atmospheres: all threaded parts are coated with a special lubrication to prevent threads from seizing; neoprene-sealed washers on the through bolts and a new type shaft seals give additional protection; the conduit box and fan cover are of cast iron for greater corrosion resistance.

For more data, circle **No. E1** on Reader's Service Card, last page this issue.



Rubber Tanks

A watermelon-shaped rubber tank has been developed by the Aviation Products division of the Goodyear Tire & Rubber Company for bulk transportation and storage of fuels and other liquids. Called the Rolli-Tanker, the container is an unconventionally-shaped tire of nylon cord and tread stock construction with fuelproof inner lining. Although the tanks can be built in a range of sizes, 3½ by 5-foot models having been tested by the company to date. These have a 250-gallon capacity and weigh 40 pounds deflated.

Mounted on hubs and axles to permit easy handling, Rolli-Tankers may be towed manually or by vehicle. The containers have excellent flotation characteristics because of extremely low ground-bearing pressure. Only 30 pounds of drawbar pull are needed to roll the storage units.

Filled containers can be towed either singly or in tandem arrangements behind any vehicle equipped with a trailer hitch without affecting the vehicle's gross weight. Low footprint pressures permit them to be drawn easily over unprepared surfaces, such as rocky, uneven terrain, swampy soil and sandy areas. Pliable construction of the tankers conform to the shape of obstacles over which they pass.

For more data, circle **No. E2** on Reader's Service Card, last page this issue.

O-Ring Flange Unions

W-S Fittings division, H. K. Porter Company, Inc., now is offering a line of 2-bolt and 4-bolt flange unions with O-Ring seals. The O-Ring provides a tight seal against fluid pressure; flanges are made of high strength forged steel with high tensile studs.

The unions are available in 3000-pound class in both screw-end and socket-welding types. The 2-bolt unions are available in sizes ¼-inch to 1¼ inches; 4-bolt unions in sizes 1-inch to 2-inch. O-Rings are available in a variety of precision molded materials to resist a wide range of service conditions.

For more data, circle **No. E3** on Reader's Service Card, last page this issue.

Long Slips

New Deal Speciality Company has announced new long slips for the running of long strings of casing in Butler Spiders. They are installed the same as regular length slips are installed. No adapters are required.

These new button type slips contain 25 percent more buttons, and the new, long conventional type slips provide the needed extra gripping surface.

(This item supplements New Deal Speciality Company, Inc., data on Pages 2644-2649 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E4** on Reader's Service Card, last page this issue.

Waste Heat Evaporator

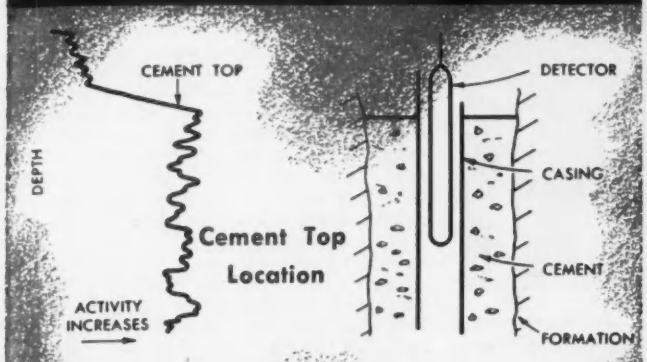
Fresh, pure water from sea water at the cost of 33 cents for 1000 gallons now is possible with the Cleaver-Brooks Company's waste heat evaporator. Utilizing waste heat from a ship's diesel engines, the evaporator in effect raises diesel efficiency from 30 to 60 percent in producing an abundant source of pure water for shipboard or offshore rig use.

The evaporator makes use of normally wasted heat dissipated in jacket heat, lube oil and diesel exhaust. It produces an abundant source of fresh water in direct proportion to waste heat available. At less than 80,000 BTU per minute, the four-stage evaporator will produce 1500 gallons per hour of pure distillate. Operation is relatively simple and maintenance free.

For more data, circle **No. E5** on Reader's Service Card, last page this issue.

Save time! Keep informed! Circle numbers on Readers' Service Cards, last page this issue

BETTER RADIOISOTOPE SERVICE



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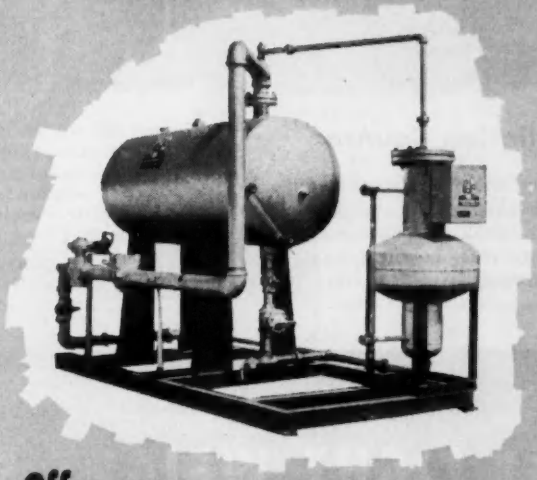
SKID-MOUNTED ROLO WELLCHECKERS with *ROLOCHECK Meters

*PATENTS ISSUED AND PENDING



Offer you complete units which separate *and* meter your production. These compact units are completely piped and ready to operate, simply by connecting the inlet and outlets to your piping.

Facilities to measure gas are provided, as well as the new, efficient ROLOCHECK Meter to meter the oil. And, as an optional accessory, a free water knock-out can be included, with a ROLOCHECK Meter to meter the free water.

The Rolo Automatic Sampler makes it complete—this optional accessory automatically samples each dump of the ROLOCHECK Oil Meter, giving you accurate information on the emulsified water percentage in the oil.

These Rolo Wellcheckers can be employed as individual separator-meter units for each well, giving a continuous record of a well's production, and allowing co-mingling of production.

Or, they can serve as test separators, eliminating the need for separate test tanks and extra piping.

For further information, contact your nearest representative or us directly.

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6332

Scintillation Counter

One of the most sensitive instruments for measuring radiation intensity, the Mount Sopris Instrument Corporation's new scintillation counter has a sensitivity of approximately 600 counts per second per microroentgen per hour. The detector array consists of four sodium-iodide crystals using magnesium oxide reflectors and quartz windows. Each crystal has a diameter of five inches and a thickness of two inches.

For more data, circle **No. E6** on Reader's Service Card, last page this issue.

FOR WORKOVER RIGS . . . SLIM-HOLE DRILLING . . .
CORING . . . GEOPHYSICAL DRILLING

GET LIGHT WEIGHT SWIVELS BY KING

Featuring light-weight swivels, the King line also includes circulating heads and wire-line strippers.
King KM Swivels are designed for drilling with chain or cable pull-down means and are intended as replacements on popular makes of pull-down type rigs. There are three sizes in the KM series.

XV SERIES SWIVELS are produced in six sizes for capacities of 15,000 to 87,000 lbs. at 100 rpm.

ALLOY STEELS assure strength with minimum weight.

OVERSIZE WATER-COURSES permit circulation of more drilling fluids.

MOLDED RUBBER COMPOSITION PACKING eliminates stuffing boxes.

HARDENED WEAR BUSHINGS, MULTIPLE BALL BEARING UNITS, SEALED HOUSINGS.

Available with conventional bail or elevator shank.

Recommended for slow to moderate rotation speeds.

3-AR and 4-AR Wire-line Strippers are safe, economical tools for wiping swabbing lines, coring lines, etc.

CATALOG

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Please order through your supply store.

IT'S A KING

KING OIL TOOLS

Export: R. S. Stokvis & Sons, 14 Battery Place, New York, N. Y. *Plant:* Box 15146, Houston 20, Texas, ORchard 3-3421

Engines

Hercules Motors Corporation has begun production on four new series of gasoline and diesel engines to augment its lines of spark and compression ignition engines. The four types now available are the light-weight, high-speed L-head gasoline engines; the line of solid injection, turbulence chamber type of diesel whose high speeds make them adaptable as gasoline engine replacements and as optional power in many applications; the new line of overhead valve gasoline engines, known as the G. O. Series, available in three bore sizes in both four and six-cylinder construction; and the new line of direct injection diesels, known as the D. D. Series, also available in three bore sizes in four and six-cylinder construction to match the G. O. Series.

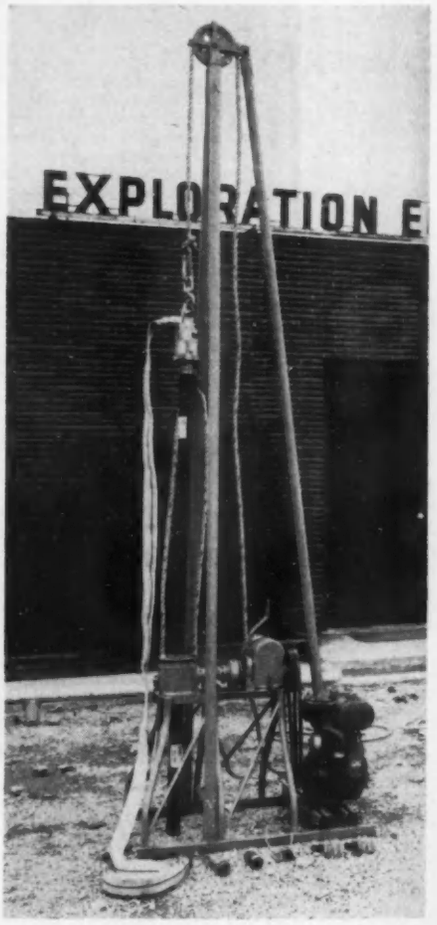
In the new GO and DD Series, engines of like size not only are interchangeable as units, but the planned program of interchangeability is further carried out in common parts and components, extending, in some cases, over the range of 12 motors.

(This item supplements Hercules Motors Corporation data on Page 2268 of the Composite Catalog, 21st Edition.)

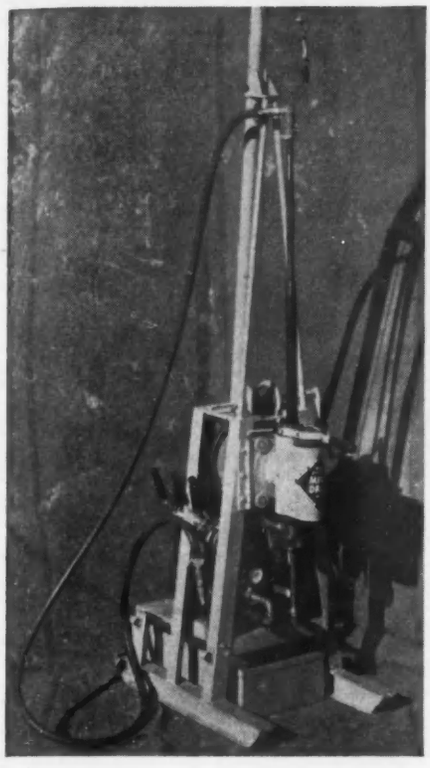
For more data, circle **No. E7** on Reader's Service Card, last page this issue.

Portable Rig

A light, portable drilling rig for geophysical operations has been introduced by Exploration Equipment Company. Demountable, the new rig easily is transported into areas which cannot be reached by truck mounted equipment. It weighs a total of 320 pounds.



For more data, circle **No. E8** on Reader's Service Card, last page this issue.



Core Drill

An improved miniature core drill has been placed on the market by Du-Jac Manufacturing Corporation. Called the Mini-Drill, it is a portable diamond core drilling rig which drills a 1 1/16-inch hole for a ½-inch core in a five or ten-foot barrel. It will drill through solid rock to provide core samples. Weighing approximately 400 pounds and with a 100-foot drill stem, it is easily carried by men, mule pack, jeep or plane.

A constant feed drill head assures continuous drilling, and rate of advance is adjustable. The drill head is hinged for quick retraction; the positive drive feed and automatic drilling retraction feed screw from one clutch. The core tube is a water-jacketed swiveling type.

Over-all length is 36 inches; over-all height to crown block is 12 feet; and over-all width is 24 inches. It operates on a gasoline engine.

For more data, circle No. E9 on Reader's Service Card, last page this issue.

Power Tubing Tong

Byron Jackson announces the addition of a new lighter-weight Hydratorc tubing tong to their line of power operated oil tools. Designated the Model S, the new tool will be a companion tong to the present Model R Hydratorc. The reduced weight contributes to easier handling, and the BJ roll-over feature is provided for reverse operation.

(This item supplements Byron-Jackson, Division of Borg-Warner Corporation, data on Pages 905-1068 of the Composite Catalog, 21st Edition.)

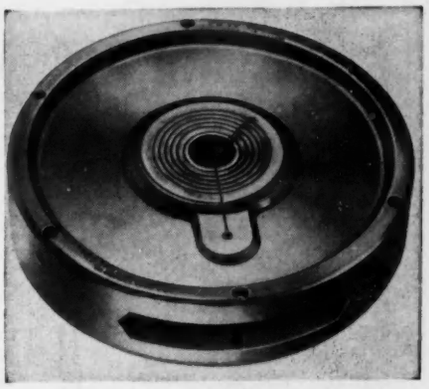
For more data, circle No. E10 on Reader's Service Card, last page this issue.

Tandem Pipe Wiper

Byron Jackson announces a series of integrally-molded PB tandem pipe wipers in 14-inch and 17-inch OD sizes, either of which may be cut out to fit any drill pipe.

Outer flanges are reinforced with two flexible metal rings which contribute to the over-all flexibility of the wiper and avoid any tendency for deforming or bending if the wiper is cocked or snagged at the master bushing or riser. Narrow ribs around the perimeter allow maximum flexibility in the thin webs of the wiper. This, together with reinforced, heavy wiping edges and reinforced relief slits, assures long service under all conditions.

Three drainage slots provide unrestricted mud flow even with the most viscous muds.



For more data, circle No. E11 on Reader's Service Card, last page this issue.

HOW LONG . . . do you wait for your Block to FALL after racking each stand of pipe?

SAVE: seconds per fall.
SAVE: minutes per trip.
SAVE: hours per well.

Illustrated left: McKissick Traveling Block designed and built for SPEED!

ANY WAY YOU LOOK AT IT IT'S . . . . . .

Streamlined, smooth flowing lines eliminate all projections. No catching on derrick girts.

Heavy center plates divide each sheave and distribute load over entire block, eliminates center pin deflection.

Extra heavy weighting at lower end of block gives better balance for straight non-wobbling falls.

Patented E-Z opening guards — Easy exposure of sheave cluster for quick reeving.

5 SHEAVE, 450 TONS — 14,000 LBS.
6 SHEAVE, 500 TONS — 16,000 LBS.

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McKISSICK BUILDS A BETTER BLOCK FOR EVERY PURPOSE

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Guy Service and Drilling Rigs this Fast Safe Way...

Cut your installation costs, save time and make certain that rigs are safely guyed with Chance Screw Anchors. Tough, all-steel construction stands up in rough use and reuse. Screws into the ground in a hurry. Can be easily removed when the job is done or left intact for future use. Holds up to 11,000 pounds in average soil.

Easily Installed

Send for catalog showing oil industry applications of Chance Earth Anchors.

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LAST 10 TIMES LONGER

Stitt "X" Type Sour Gas plugs resist corrosive action of sour gas — last months longer — require fewer changes—cut "down" time. It's not the plug price, but the "change cost" that's important! Stitts cost a little more — save hundreds of dollars per engine per year. Factory equipment in Clark, Cooper-Bessemer, Worthington, other leading engines.

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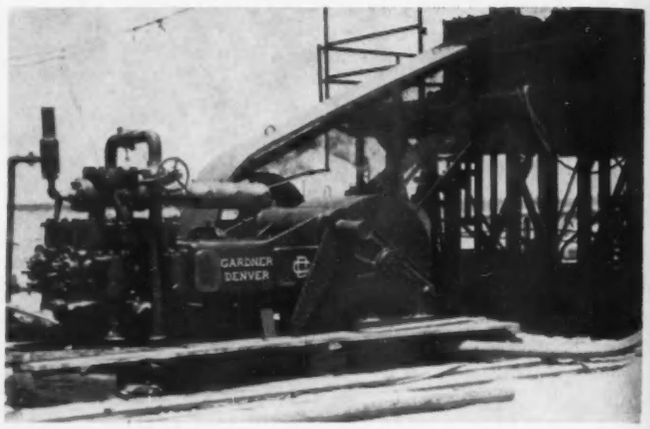
and Supply Stores Everywhere.

NEW EQUIPMENT . . .

Mud Pump



Gardner-Denver Company has increased their GX line of mud pumps with the addition of the 500-horsepower model GXN. The new model is a 14-inch stroke pump with 7¼-inch diameter fluid cylinders. It has been designed with heavy-duty bronze sleeve jackshaft bearings, eccentric and crosshead pin bearings. The connecting rod has been designed as one piece to eliminate possibility of bolt failure under load.

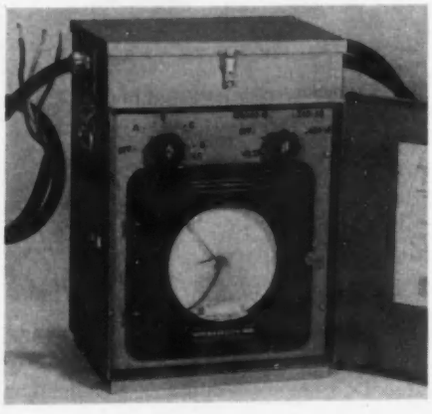
Two chain driven positive displacement pumps, assembled in the completely enclosed power end, insure a supply of lubricating oil to the bearing surface. A packed oil-stop head and large piston rod baffle prevent mud from entering the power end. The piston rod extension is threaded and locked in the crosshead to prevent parts from working loose.

When operated at the recommended speed of 70 revolutions per minute with master size 7¼-inch liner, the GXN displaces 666 gallons per minute, and is suitable for pressure up to 1094 pounds per square inch. With reduced size liners, the pumps handles pressure up to 2435 pounds.

(This item supplements Gardner-Denver Company data on Pages 1869-1888 of the Composite Catalog, 21st Edition.)

For more data circle **No. E12** on Reader's Service Card, last page this issue.

PRODUCTION



Pumping Cycle Analyzer

Austin Meter Services has announced that a pumping cycle analyzer has been designed to determine the producing cycle of an electrically powered pumping well so that the on and off periods can be balanced for reduction of power costs and capacity of the well increased.

The device is compact, portable and weatherproof and it can be moved from well to well by a single operator. It will operate on 120/240 volts single phase, 240 volts three phase and 480 volts three phase and will provide ample registration on motors ranging from 2 to 15 horsepower.

The instrument consists of a graphic demand meter, potential transformers with voltage selector switch, current transformers with horsepower selector switch and 3-conductor cable for connecting the device in the circuit.

For more data circle **No. E13** on Reader's Service Card, last page this issue.

Retrievable Valve Mandrels

Camco, Incorporated has marketed new oval shaped Type KBM and KCM retrievable valve mandrels for gas lift that permit separate running of two parallel strings of 2-inch tubing in 7-inch casing. This parallel string installation with all valves for both zones selectively retrievable provides a full open tubing bore through which any normal wire line operation, including swabbing and perforating, can be performed.

The new KBM mandrel provides a full open $1\frac{15}{16}$-inch bore with valves in place. It accommodates Camco's pressure operated valves, with all valves selectively retrievable.

The New Type KCM mandrel has same maximum and minimum OD's of $4\frac{13}{64}$-inch and $2\frac{29}{32}$-inch as does the Type KBM. It is used for deeper lifting in excess of 7000 feet with large bellows valves seated in the mandrel.

These mandrels will withstand in excess of 6000 psi internal burst pressure and in excess of 5000 psi external collapse pressure.

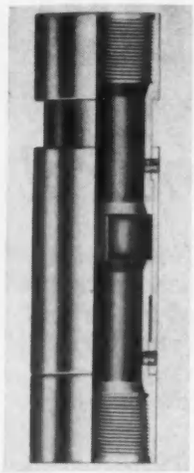
(This item supplements Camco, Incorporated data on Pages 1080-1081 of the Composite Catalog, 21st Edition.)

For more data, circle No. **E14** on Reader's Service Card, last page this issue.

Circle numbers on Readers' Service Cards on last page

Liner Adjuster Coupling

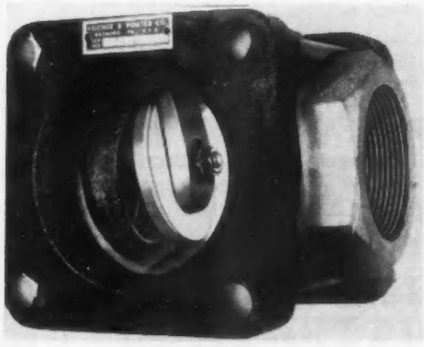
An adjuster coupling that replaces the standard coupling on liner strings and prevents compaction or tension damage to liners and screens recently was introduced by Creighton Oil Tool Company. The adjuster coupling has a 2-inch stroke up or down from center, and two sets of shear pins make it possible to provide one shear point in tension and a different shear point in compression.



The case is equipped with splines so the coupling is handled in the same manner as a standard solid coupling. A full range of pipe sizes is available, with shear pins to specifications.

(This item supplements Creighton Oil Tool Company data on Page 1348 of the Composite Catalog, 21st Edition.)

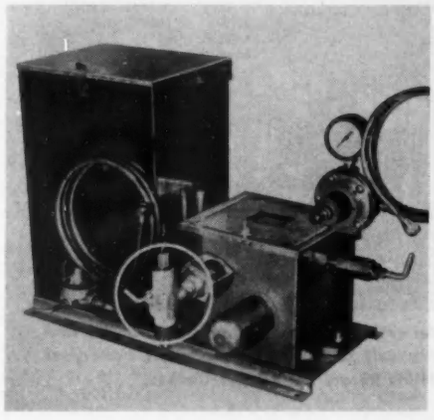
For more data, circle **No. E15** on Reader's Service Card, last page this issue.



Sight Flow Indicator

A sight flow indicator which combines flow indication with positive check of back-flow has been introduced by Fischer & Porter Company. The device has a self-aligning soft seat flapper which prevents back flow. Two ½-inch thick windows on opposite sides of the body fitting, removable for easy cleaning, show clearly whether or not there is a flow. The indicator does not measure rate of flow. The rugged through-bolted construction is suited for severe service in the process industries and permits cleaning sight glasses without removing the unit from the pipe line.

For more data, circle **No. E16** on Reader's Service Card, last page this issue.

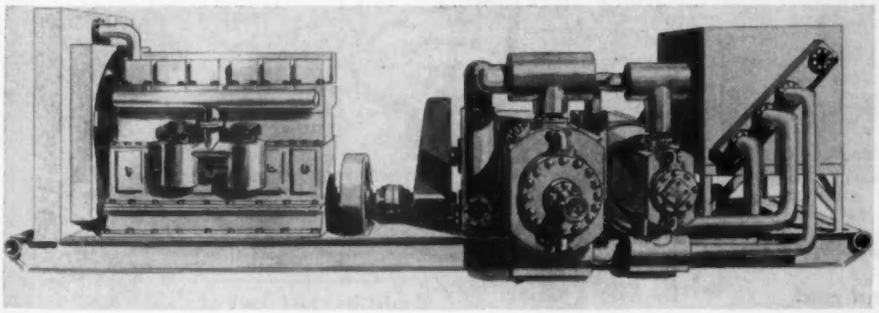


Chemical Injectors

Texstream Corporation has supplemented their chemical injectors series with two models of advanced design, the Series 1200 (S-Beam type) and 3700 (gas driven type). An important change is in the injector pump head, now made of Meehanite castings instead of brass or bronze. All pump packings now are of Hycar.

The new Meehanite head offers greater resistance to a wider range of corrosive action. It satisfactorily handles almost all compounds commonly used for emulsion breaking or corrosion injection service.

For more data, circle **No. E17** on Reader's Service Card, last page this issue.



Gas Pick-Up Compressor

A compact, highly efficient riciprocating compressor has been announced by The Cooper-Bessemer Corporation. V-angle compressors have been incorporated in the new unit which ranges in capacity from 100 to 300-horsepower. Ruggedly built and operated at a relatively slow speed, it provides the stamina needed for efficient operation under the most adverse condition.

For maximum versatility, cylinders of the compressor can be mounted singly for single-stage compression, in tandem or as twin units for two or more stages, adapting the unit to a wide range of services.

The compressor also can be skid-mounted to operate as a portable unit or can be mounted on a conventional concrete base. It may be belt-driven from an electric motor or power-driven from a conventional gas or diesel engine.

(This item supplements The Cooper-Bessemer Corporation data on Page 1345 of the Composite Catalog, 21st Edition.)

For more data, circle **No. E18** on Reader's Service Card, last page this issue.

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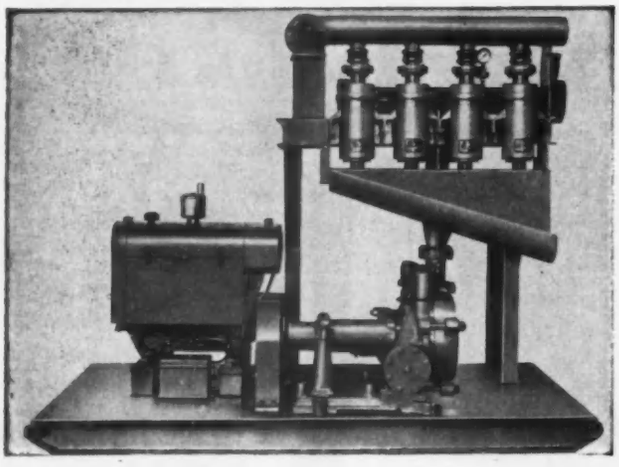

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New Equipment Catalogs and Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader's Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card. Requests are transmitted to the manufacturer as soon as received by us for mailing of desired information directly to you.

Docks, Mobile Drilling Barges

De Long Corporation has issued an illustrated booklet describing De Long jacks and De Long technique of dock construction, of which the famous Texas Tower is one application. Other illustrated De Long installations include drilling platforms, piers and wharves.

The De Long steel mobile drilling barges can be pre-fabricated anywhere in the world, in shipyards where costs are controlled. Then the De Long dock-barge, carrying its own installation gear, is towed to site. Units are now in service from the Arctic to the Tropics, including several drilling platforms in the Gulf of Mexico. The colorful booklet gives the complete story; predicts new applications to come.

To get a copy circle **No. E19** on Reader's Service Card, last page this issue.

Industrial Hose Catalog

An industrial catalog, released by Aeroquip Corporation, covers the full range of Aeroquip products: low, medium and high pressure hoses for air, water, fuel, lube and hydraulic applications, as well as special hoses for steam, LPG, Freon and fire-resistant hydraulic fluids and detachable, reusuable fittings and couplings.

The catalog also provides answers to fluid line problems encountered by designers of machine tools, trucks, construction equipment, engines and other industrial products.

To get a copy, circle No. **E20 on** Reader's Service Card, last page this issue.

Slush Pump Bulletins

National Supply Company's largest power slush pumps are described in two new bulletins which cover features, construction details, performance, and specifications of the G-700 and G-1000 pumps respectively. These pumps are rated at 700 and 1000 input horsepower and have bores and strokes of 8 by 14 and 8½ by 16 inches.

To get a copy circle **No. E21** on Reader's Service Card, last page this issue.

Waste Heat Evaporators

New Cleaver-Brooks Company heat evaporators transform sea water into fresh water at no fuel cost but utilizing the waste heat from diesel engines or gas turbines. Information on five models with capacities from 300 gallons per hour up to 2100 gph now is available in Cleaver-Brooks latest brochure, "Fresh Water by the Ton."

The brochure contains a comparison chart showing savings possible with a Cleaver-Brooks waste heat evaporator when compared to vapor compression or multi-effect evaporators and barged-in water. It tells how offshore drilling operators can save up to $25,000 a year by producing fresh water from sea water on board at no fuel cost.

To get a copy circle **No. E22** on Reader's Service Card, last page this issue.

Valve Circular

An illustrated circular, describing the new Luncor valve and fittings, first all-molded corrosion-resistant PVC valve designed by a valve manufacturer, has been published by the Lunkenheimer Company. Luncor PVC valves overcome disadvantages of other materials in handling a wide range of acids and alkalis and in resisting chemical attack and deterioration. A thorough series of tests and practical performance in all types of corrosive installations have proved their suitability for the rigorous demands of piping systems handling corrosives. Detailed information including advantages, installation data and dimensions of Luncor PVC valves and fittings is contained in the new circular.

To get a copy, circle **No. E23** on Reader's Service Card, last page this issue.

Roller Bearings Catalog

Greater load capacity and simplified application, resulting in over-all economy, are two of many features of Link-Belt Company's self-aligning roller bearings which are described in detail in a new book just released by the firm.

The book describes Series S, adjustable single-row self-aligning roller bearings; Series D, adjustable double-row bearings; and Series M, pre-adjusted double-row self-aligning bearings. It also gives engineering selection information, complete dimensional specifications and recommended fitting practices.

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V-Belt Drive Data

Origin, history and development of the modern multiple V-belt drive is discussed in a new pocket size booklet released by Allis-Chalmers Manufacturing Company. The booklet covers evolution of standards in engineering V-belt drives, tells how to engineer a V-belt drive, provides tables and data, and describes modifications in V-belt drives. Final chapter answers questions relating to some of the basic principles and practices involved in enginering and use of multiple V-belt drives.

To get a copy circle **No. E25** on Reader's Service Card, last page this issue.

Diesel Report

"Why Cat Diesels Are Best," Caterpillar Tractor Company's latest booklet, lists some of the features incorporated in the manufacture of Cat engines. Advantages of diesel engines over gasoline engines and characteristics which distinguish Cat diesels from other types are explained.

Turbocharging is discussed, with a schematic drawing illustrating data presented. Actual photos of customer installations also are included.

To get a copy circle **No. E26** on Reader's Service Card, last page this issue.

Rubber Products Catalog

The 1956 edition of the PB Oilfield Rubber Products Catalog has been published by Byron Jackson Division of Borg-Warner Corporation. The two-color catalog illustrates and describes the complete PB product line, product classifications including casing protectors; stabilizers; kelly sub rubbers; pipe wipers; wire line guides; dead-line stabilizers; mud guns; mud tank connectors; swivel, link, crown and traveling block bumpers; wire line, sucker rod, and tubing wipers; and sucker rod and tubing couplings with molded-on protectors. Included are more than 500 code names.

A feature of the catalog is bar-graph clearance charts for easy selection of correct casing protector and stabilizer sizes. Detailed selection and installation instruction also is given on all products where such information is helpful, and complete parts and price information is provided for all products and models.

To get a copy circle **No. E27** on Reader's Service Card, last page this issue.

Oil Control Circular

An illustrated circular describing the line of Alvor constant level oil controls; bottle oilers for plain bearing lubrication; Sentinel, Royal and Pioneer glass body oil cups; and Alsen aluminum body oil cups has been released by Lunkenheimer Company. Circular includes detailed dimensions and installation instructions covering a wide range of applications.

To get a copy circle **No. E28** on Reader's Service Card, last page this issue.

Hose Coupling Brochure

Anchor Coupling Company has released a catalog describing and illustrating the patented "Flanco" 4-bolt, split-flange coupling for high, medium, low and suction return applications. Such features as the O-Ring seal, ease of installation, and savings in weight and production costs made possible by use of the new tilt and blowout proof coupling are pointed out.

To get a copy circle **No. E29** on Reader's Service Card, last page this issue.

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